APRIL 1961

Precision Metal Molding

INCLUDING DIE CASTINGS MAGAZINE

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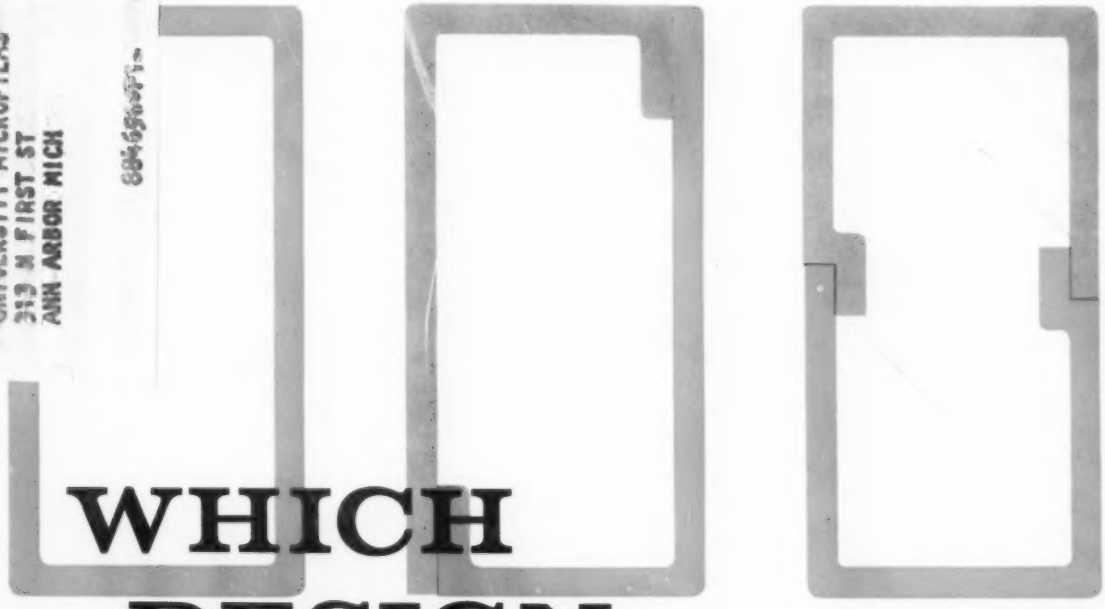

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SEE DESIGN WITH ALUMINUM EXTRUSIONS

in this issue
10th annual POWDER METALLURGY DIRECTORY & BUYER'S GUIDE

AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

PMM

The magazine for design, finishing and the use of:

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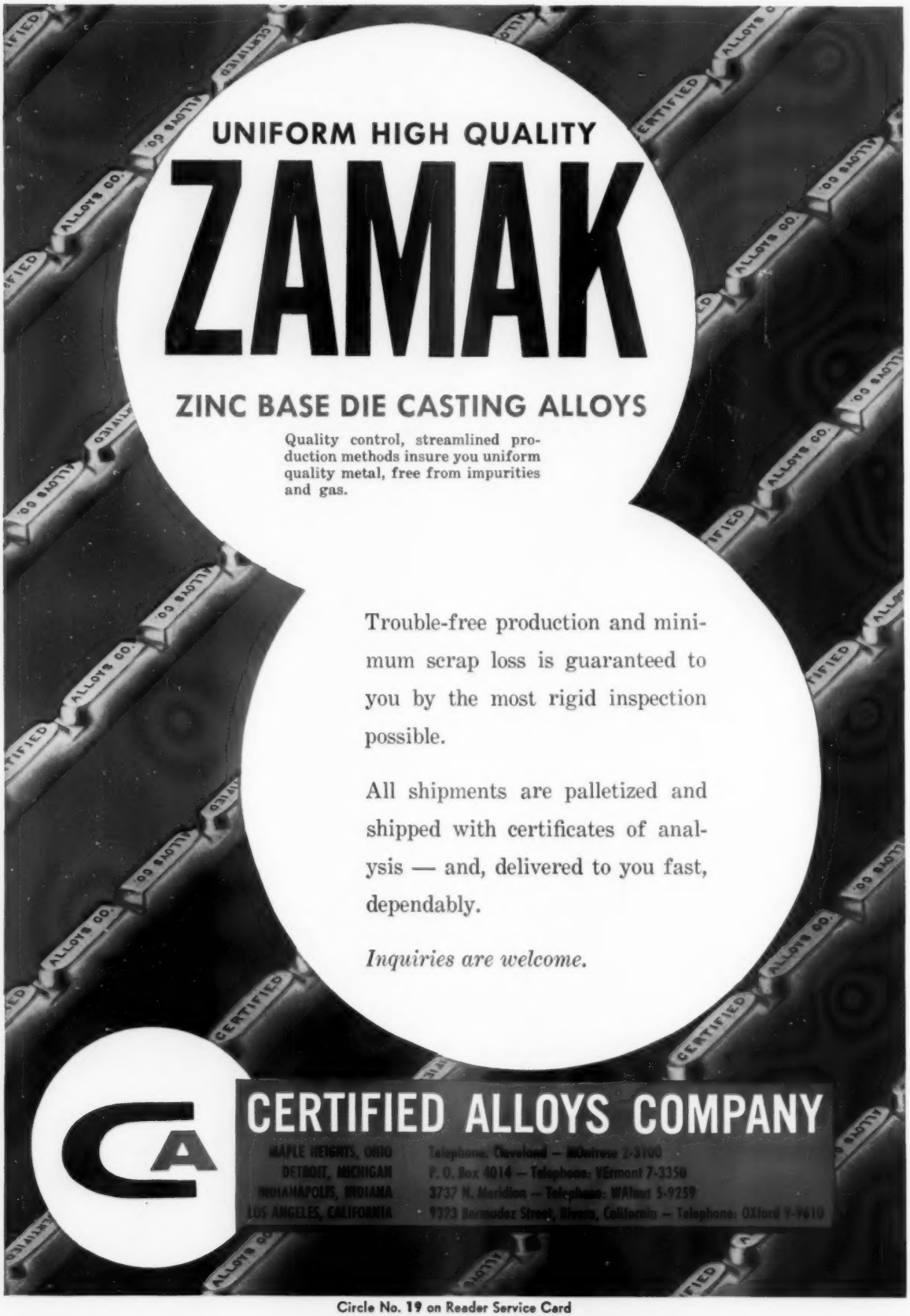
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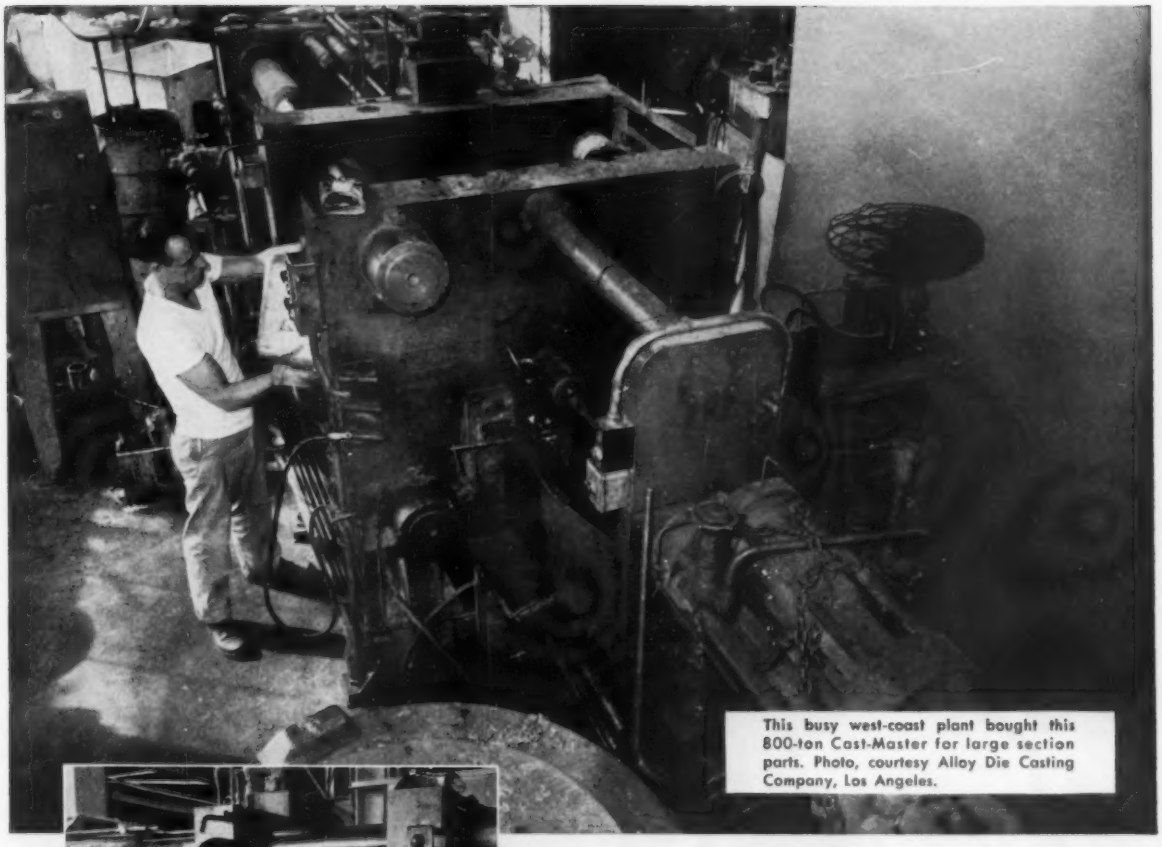

This busy west-coast plant bought this 800-ton Cast-Master for large section parts. Photo, courtesy Alloy Die Casting Company, Los Angeles.

Big, husky, thick section parts with accurate detail and true conformity to close tolerances. These machines are adjustable to all variables within its size range.

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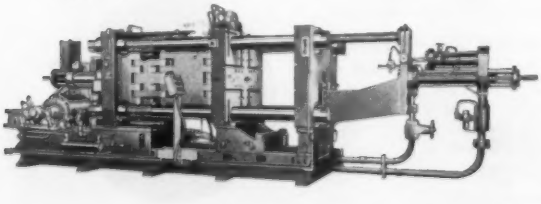

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Southern Die Casting And Engineering

October 24, 1960

Mr. Rex Harrison
International Foundry Supply Company
Post Office Box 1053
Reading, Pennsylvania

Dear Mr. Harrison:

We are enclosing with our letter, our signed report on the melting test which was conducted in our plant on October 3rd, 1960.

We are very pleased with the report as your .81% melting loss figure is confirmed throughout melting approximately 30 Tons of aluminum. Our machine operators report less fatigue with the Reverbale furnace and better casting conditions which we find reflected, in the fact that our rejects are at an all time low.

May we express our appreciation, in particular, to the service that your company has given us, and your continued interest in helping us improve our melting techniques.

Very truly yours,

John A. Weber
Vice President
Southern Die Casting & Engineering

JW:dm

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OF

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Melting Superiority

REVECON FURNACES — TECHNICAL REPORT

Furnace No. GC 60071150 Type Reverbale Jr. Fuel Natural Gas General Condition Good

REPORT ON MELTING TESTS — Date October 3, 1960

No.	METAL From	METAL Type	Time Charged	Time Ready	Time Poured	FUEL GU FT / GALS Start	FUEL GU FT / GALS End	FUEL GU FT / GALS Amount	CHARGED Lbs.	POURED Lbs.	LOSS Lbs.	% LOSS	Temp. Flue — Pour Temp. etc.
Preheat			9:40	10:06		9820	9100	280					
1	Pig	500	10:06	10:32		9100	8870	520	247	245	2	0.81	1350 °F
2	Pig	500	1:45	2:15		0190	0470	280	245				1350 °F

Cost to melt:

Metal Loss	$ .020205
Fuel	.003672
Flux	.001100
Refractories	.000150
TOTAL COST TO MELT PER POUND	$ .0049427

Witnessed by: John A Weber, Vice-President
Report Checked by: Southern Die Casting and Engineering Company

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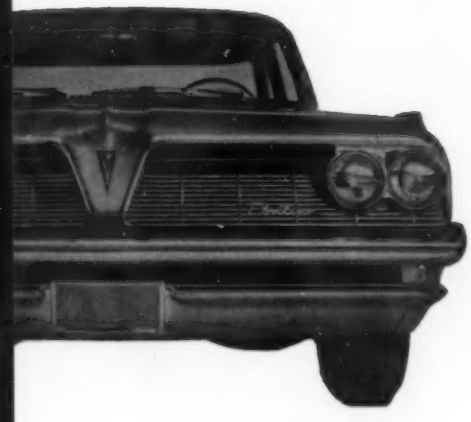

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PMM letters

the readers' forum

Hand operated die casting machine

We are interested in obtaining an old, hand operated die casting machine. Perhaps you or your readers might know where we can locate this type machine. If you have such information, please forward it to Mr. David Payne, Production Manager, Crescendo Drum Co., 9327 Richter St., Detroit 14, Michigan.

The names of several possible sources for hand operated die casting machines have been forwarded to this reader. Meanwhile, it is hoped that readers knowing the whereabouts of this type machine will contact Mr. Payne.—Ed.

Plaster mold castings

We are interested in casting bronze parts by Gypsum casting. If you have information available on this process, or can refer us to a source, please do so.—J.D., Purchasing Agent.

We suggest that this reader contact the United States Gypsum Corp. for general information on casting bronze in plaster molds. If they wish to contact an outside supplier, we suggest they contact Atlantic Casting & Engineering Corp., Clifton, New Jersey or Ohio Precision Castings, Inc., Dayton, Ohio.—Ed.

Home workshop

The January 1961 issue of PMM discusses a piece of home workshop equipment made in England by Horstmann and Sherwen. It would be appreciated if you would furnish the address of this company.—J.H.K.

We are sorry that we cannot furnish the address of Horstmann and Sherwen. However, the Zinc Development Association, London, England will probably be able to supply this information.—Ed.

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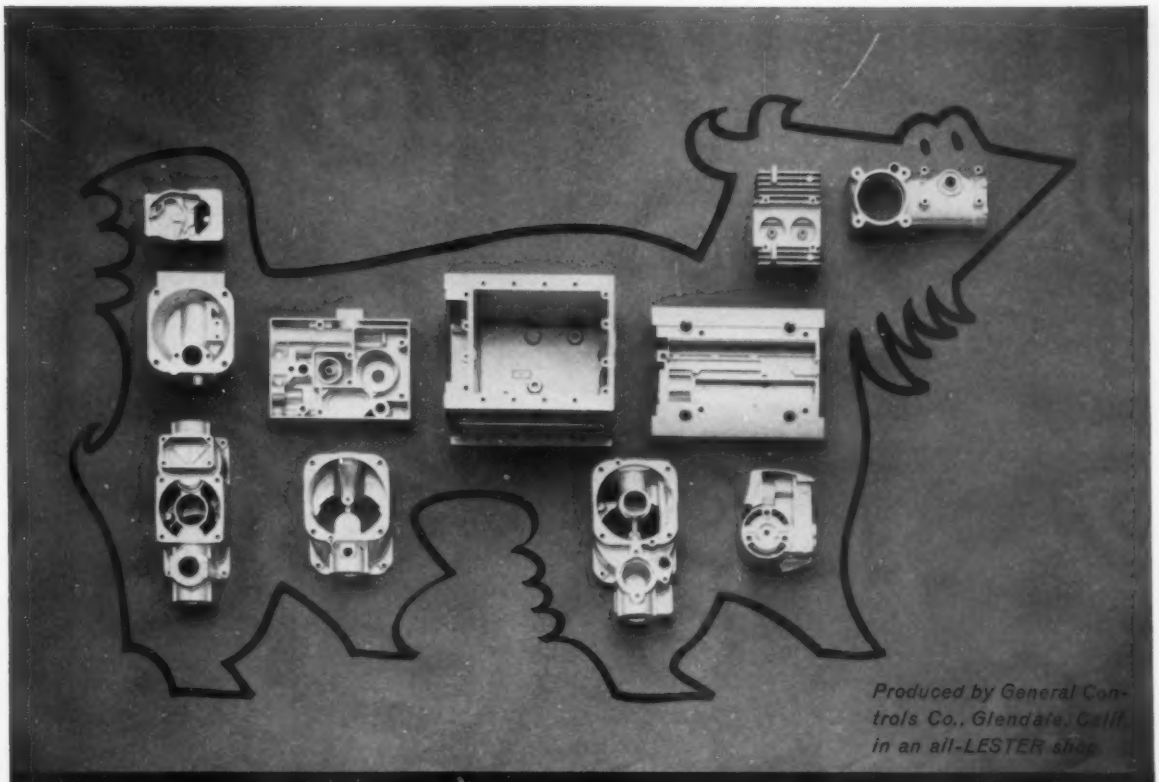

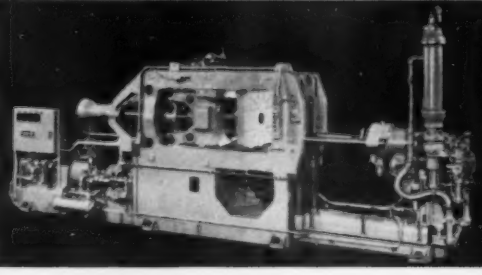

THESE DIE CASTINGS ARE A DIFFERENT BREED OF ANIMAL

The aluminum die castings pictured above may *look like* typical die castings. They are, in fact, a different breed, because they are used to do a job that ordinary die castings *can't* do. As control parts for gas and oil appliances, they must withstand test pressures as high as 300 PSI in some cases. These are PRESSURE-TIGHT CASTINGS!

These die castings are concrete evidence of the special values built into Lester Die Casting Machines. Wilf Botfield, Master Mechanic at General Controls Co. in Glendale, California, where these parts are produced, says: "We couldn't produce this kind of casting except for the absolutely square lock-up of the Lesters. Any flash and the interlocking cores would be plugged solid with metal. And we can't put up with any "normal blow-back"... it would ruin critical dimensions ($\pm$.003" to .005"), waste metal and complicate our trimming. For a steady run of flash-free, leakproof parts with the detail and finish we require, nothing beats a Lester."

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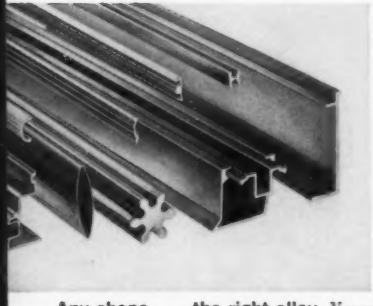

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PMM

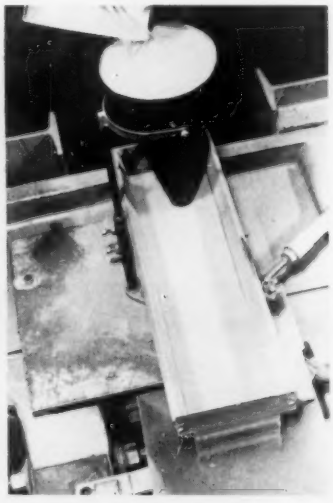
casting about *technical news of applications & processes involving precision metal molding*

Copper Rod, Bar and Strip Without Melting

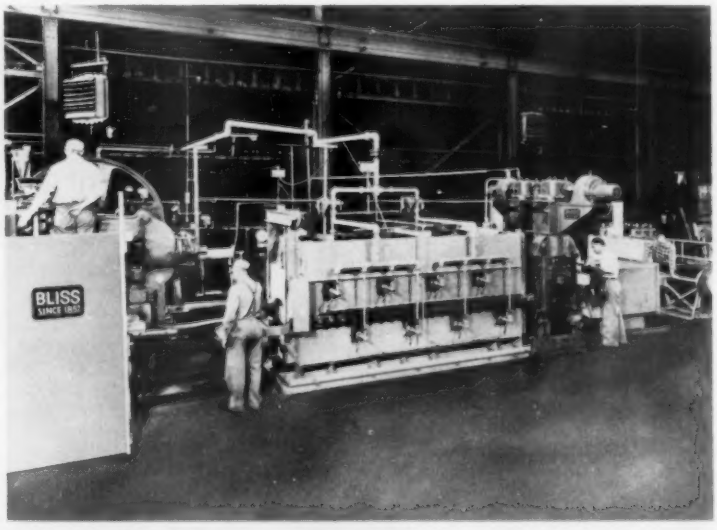
OVER TWENTY YEARS AGO, Dr. Rhines, then professor of metallurgy at Carnegie Institute of Technology, said; ". . . when powder metallurgy is able to start with ore and end up with a fabricated product it will have come of age. But it must do this without any pyrometallurgical steps such as the blast furnace or the open-hearth."

Dr. Rhines went on to say; "I can envision the day when sheet, strip, rod, bar, and even plate stock will be produced without the metal ever being melted and cast." Dr. Rhines was more prophetic than he thought. Within the next few months a 23 million dollar plant will be built

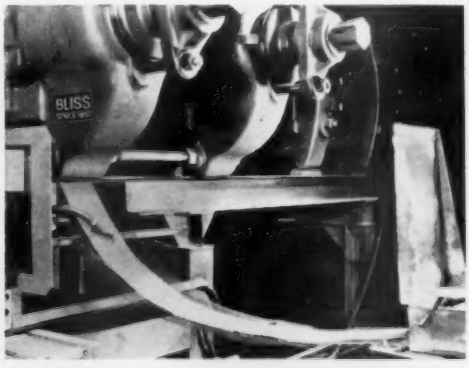
continued on page 12



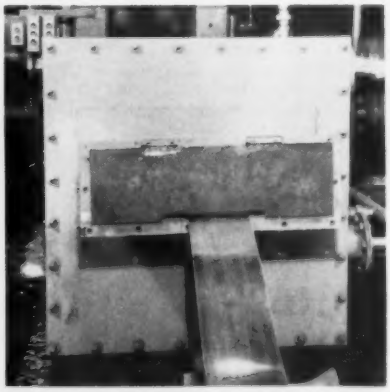
COPPER POWDER is produced chemically and fed into a hopper and guide arrangement.



ROLLING EQUIPMENT for making strip is fed copper powder from left, strip emerges at right.



ROLLS AND FEED DEVICES keep green compact uniform.



COPPER STRIP EMERGES. Tests have shown superior mechanical properties, lower oxygen content.

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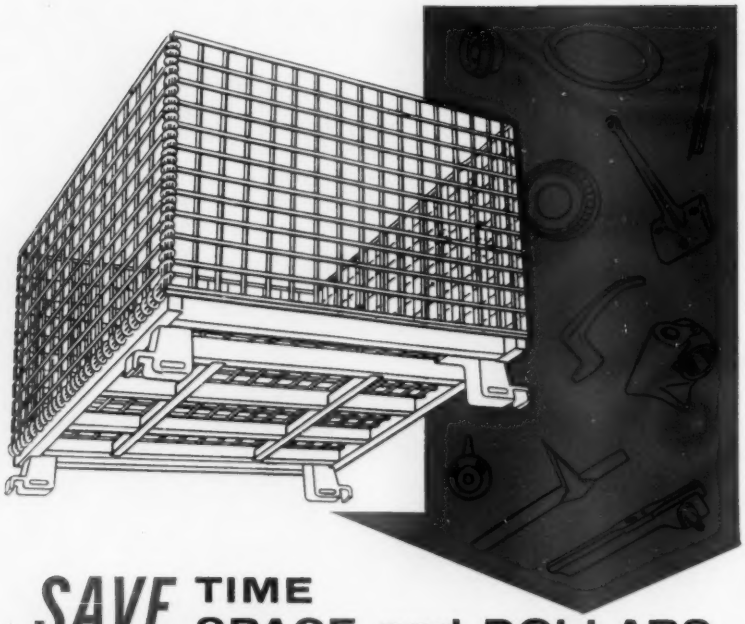

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casting about

Continued

in the Philippine Islands to produce copper products by powder metallurgical methods.

The process to be used will leach the copper from the ore and then precipitate copper powder, under high temperatures and high pressures, from the leach solution. After drying, the copper powder will go to specially designed rolling mills where it will be compacted into strip, pass through a sintering furnace, and then into conventional hot and cold rolling mills. Alternately, seamless tubing may be produced by extrusion, possibly directly from the powder.

What are the advantages of this process? Present estimates put capital investment at 40% below a conventional refinery and a 50% saving in the fabricating equipment investment.

The new plant will produce about 14,000 tons of copper per year and 100,000 tons of ammonium sulfate fertilizer per year. About 5,000 tons of zinc will also be available as a by-product.

This Philippine plant will be the first fully integrated one ever built. Sherritt Gordon Mines, Ltd. and Chemetals Corp. have worked for the past 20 years on the development of the leaching and reduction phases of the process. A refinery working on nickel concentrates is operated by Sherritt Gordon at Fort Saskatchewan.

The fabricating facilities have been developed by the E. W. Bliss Co. over the past five years. They have had a rolling and sintering pilot plant operating in their Salem, Ohio plant for some time. The new plant will, however, be the first time that both phases of the process are integrated.

While the new plant is hailed by many as a big step forward in the refining and fabricating of metals, others feel that only exceptional economic conditions will allow it to operate successfully.

NOW AVAILABLE TO DESIGNERS AND PRODUCT PLANNERS

*PDCS

***PROTOTYPE DIE CASTING SERVICE**

A NEW PROCESS WHICH PROVIDES PROTOTYPE DIE CASTINGS WITHOUT HIGH COST TOOLING

What is PDCS?

Prototype Die Casting Service is a refinement and perfection of a plaster mold casting process which has been developed over a period of a year and a half of intensive research and test to a point which allows the low cost creation of simulated die castings, in small quantities, without the cost of conventional, permanent tooling. A Prototype Die Casting looks, feels, finishes and performs remarkably similar to a production die casting.

Why Was PDCS Developed?

The growing demands of designers, product planners, purchasing officials and sales management personnel prompted Newton-New Haven Company's development of the process. While the individual needs of all were different, the basic need behind them all was identical . . . a production method which would allow them to secure . . . each for their own reasons . . . small, low cost quantities of simulated die castings without underwriting permanent tooling charges.

How Can You Use PDCS?

If part of the product you are planning is to be a die casting and your customer requests samples before placing orders, PDCS can represent the solution to your problem. Or, if you wish to test the function of an assembly which includes a die casting . . . determine the strength of a die casting as applied to your needs . . . gauge the sales appeal of your product by sampling . . . judge the "feel" and appearance of a die casting . . . PDCS provides the means. If you are interested in holding down the cost of new product development and avoiding expensive design errors it will pay you to fill out the coupon in this announcement and mail it today as a first step in learning more about PDCS.

How Much Does PDCS Cost?

Very little compared to the advantages and cost savings PDCS can achieve for you. The factors determining cost are shape and complexity of the part as well as the quantity required.

How Can You Start To Work With PDCS?

If you have a part in design to which you believe PDCS may provide an answer and you have prints of the part to be Prototype Die Cast, forward the prints with an indication of the quantities you will require. A cost-estimate will be sent to you. Should you have a model of the part, but no prints, the model may be sent in for cost-estimating purposes. If you have just an idea about the part and not prints, sketches or models, a Newton-New Haven Technical Representative will call on you and assist in the development of drawings sufficient for cost-estimation.

From your prints, models, sketches or ideas, if part of your product is to be a die casting . . . start with PDCS

* *This name identifies an exclusive service of the Newton-New Haven Company, developed to serve the needs of Designers, Product Planners and others in industry interested in die castings as the quality method of mass production.*

THE NEWTON-NEW HAVEN CO.

680 THIRD AVENUE • WEST HAVEN, CONN.

CUSTOM PRODUCERS OF DIE CASTINGS

I have a problem to which PDCS may be the solution. Without cost or obligation to me or my company . . .

☐ Models ☐ Prints ☐ Sketches are being forwarded under separate cover. Please submit your cost-estimate.

☐ Have your representative call.

☐ Send me your free folder, "PDCS . . . Prelude to Production".

NAME: _____

TITLE: _____

COMPANY: _____

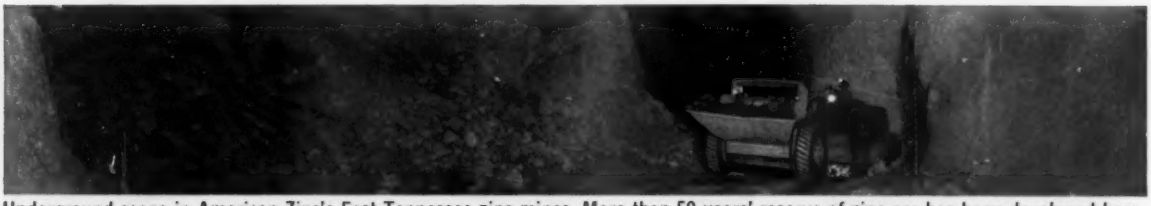
ADDRESS: _____

DIE CASTING RESEARCH FOUNDATION PARTICIPANT

NEWTON NEW HAVEN

Circle No. 57 on Reader Service Card

INTEGRATED PRODUCTION —from Ore to Ingot



Underground scene in American Zinc's East Tennessee zinc mines. More than 50 years' reserve of zinc ore has been developed here.

Assures the Uniformity and Purity of

Cell room in American Zinc's electrolytic zinc plant at Monsanto, Ill. Special high-grade zinc is produced at this modern refinery.

AZCO Zinc Die Cast Alloys

Latest spectrographic analyzing equipment is employed to assure accurate control of alloys at all times.

You set your specification—get your specification with AZCO Zinc Die Cast Alloys. AZCO Alloys are produced from American Zinc special high-grade slab zinc—quality controlled from ore to ingot to assure the purity and uniform analysis you need for trouble-free production. From our Monsanto, Illinois, plant in the center of the "Zinc Zone," you get the fast, dependable service you need to meet your production schedules. Phone for immediate attention.

American Zinc sales company

1515 Paul Brown Building, St. Louis 1, Missouri

Distributors for:

AMERICAN ZINC, LEAD AND SMELTING COMPANY

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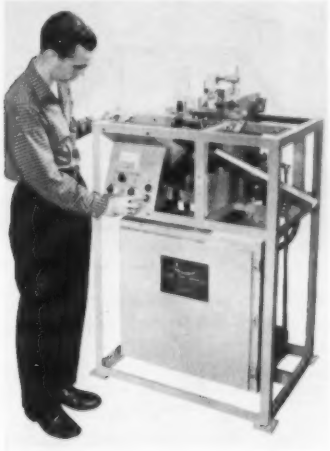
Circle No. **10** on Reader Service Card

PMM

new products & developments *qualified readers can get complete details on these products. Use the reader service cards.*

Automatic comparator rejects wrong weights

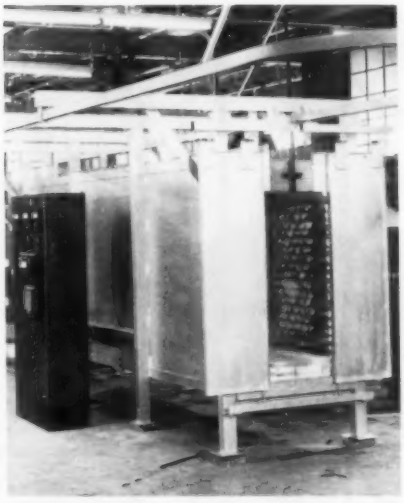
ATRONIC PRODUCTS, INC.—The Atronic Weight Comparator automatically selects and rejects parts, billets or other materials that have the wrong weight before passing them on to the next production step. Weights to



within ± one gram of that required is said to be possible. In extrusion operations it handles and weighs billets to find out if they are within acceptable limits.

Circle No. **236** on Reader Service Card

Enameling furnace-conveyor combination speeds production

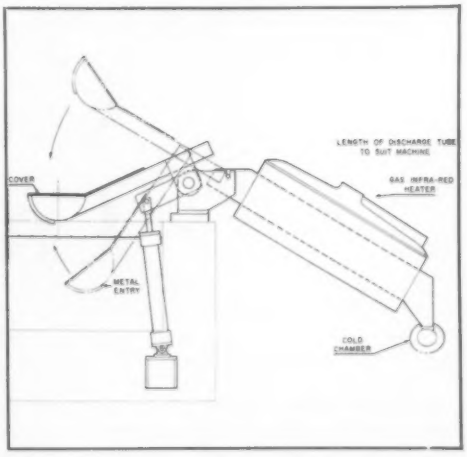


WALTZ FURNACE CO.—A new 30′ continuous enameling furnace enables manufacturers to enamel and fire metal parts in production line fashion. Parts are placed on hangers that project through a slot in the roof and operate from an overhead conveyor. Variable speeds permit the firing of different types of enamel at different rates. Both undercoat and final enamel coat can be done in the furnace. It is designed to handle all types of parts.

Circle No. **235** on Reader Service Card

Automatic ladle delivers clean casting metals

J. A. KOZMA CO.—A new automatic ladle is said to deliver clean metal to the cold chamber of die casting or permanent mold machines, quickly, accurately and dependably. Bottom entry and cover provide subsurface fill to minimize oxide inclusions and hydrogen absorption. All surfaces in contact with the metal are coated with a special nonwetting ceramic. If the die does not lock up, an electrical control system prevents metal pour.



Circle No. **237** on Reader Service Card

more New Products on page 20

50-lb. ingot

25-lb. ingot

10-lb. ingot

Casting? Call Olin.

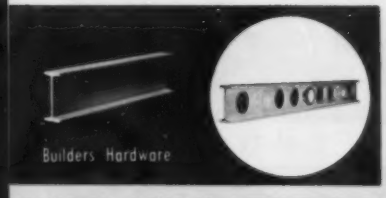
All Olin Aluminum distributors carry a wide range of casting alloys in immediately available stock from the 10-lb. ingot to the exclusive 25-lb. ingot and the 50-lb. ingot. Olin Aluminum sales offices and distributors also offer you a full range of technical service backed by Olin's metallurgical staff and laboratories. This service includes help in metal selection and application advice, tips on casting and finishing aluminum. Why not make Olin Aluminum your source of primary casting alloys—and the latest metallurgical know-how. Call your local Olin Aluminum distributor or nearby sales office and get experienced help on any of your foundry problems.

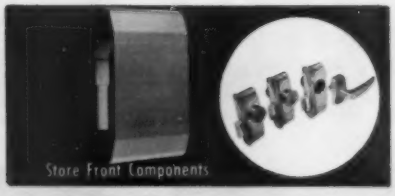
Olin ALUMINUM®

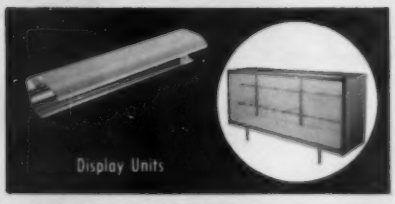
400 PARK AVE., NEW YORK 22, NEW YORK

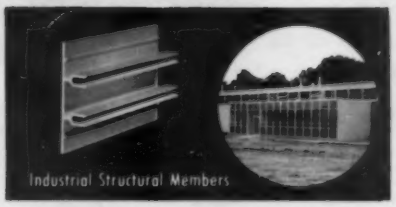
Circle No. **87** on Reader Service Card

ROGERS INDUSTRIES PUTS ALL YOUR ALUMINUM NEEDS IN SHAPE . . . *at lowest cost!*









Just a few of the many applications of aluminum extrusions. Let Rogers "Imagineering" develop an application of aluminum for your product, or help improve your present application.

FINEST QUALITY ALUMINUM EXTRUSIONS FOR EVERY BUSINESS and INDUSTRY

MAIL THIS HANDY POST-PAID CARD TODAY!

Have a Rogers engineering representative contact you right away. He'll analyze your product needs, help draw up plans—demonstrate how to solve production problems and effect new economies for your operation.

ROGERS INDUSTRIES, INC.
Extrusion Division, Dept. PM
14575 Meyers Road
Detroit 27, Michigan

Gentlemen:

Please contact us with details of Rogers versatile Extrusion Program.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____

STATE _____

TYPE OF BUSINESS _____

HERE'S WHY YOU CAN RELY ON ROGERS INDUSTRIES

FOR ALL YOUR ALUMINUM EXTRUSIONS

Rogers skilled engineering staff specializes in solving production problems—developing improvements for the extrusions you now use and *new* cost-saving applications you may have overlooked.

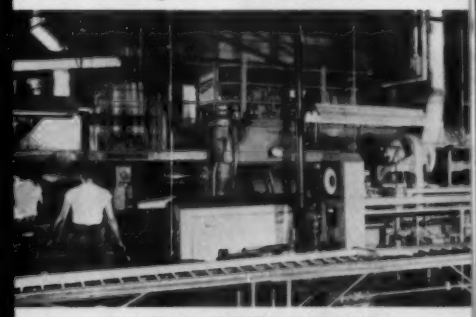
Whatever the job, you get the benefits of Rogers' production experience, thorough inspection techniques and strict adherence to close tolerances. Finest quality *guaranteed* from raw material to finished job . . . Quality you enjoy without sacrifice of valuable time. Rogers maintains a full stock of raw materials—provides multiple-press facilities at separate locations for complete, dependable service at all times.

And there's economy, too! Save premiums for "short runs". Save time with prompt delivery by Rogers own truck fleet.

Talk to the Rogers representative today!

ENGINEERING CONSULTATION

QUALITY CONTROL



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Detroit 27, Michigan

1961 DESIGN ENGINEERING SHOW

and Concurrent **ASME** conference

COBO HALL

Detroit · May 22-25

Put those important product drawings and specifications in your briefcase. Make a list of original equipment you want to know more about. Get a big notebook, and pack a pair of comfortable walking shoes. Then head for Detroit's magnificent new Cobo Hall and the biggest, most exciting Design Engineering Show in history.

The best design and development work that over 350 companies can come up with is ready for you to see, compare, and study. The top application engineers of these companies will be on hand to discuss their products with you – go over drawings and specifications – make suggestions – offer you the benefit of their cumulative experience.

Everyone with design-engineering responsibility will benefit from DESIGN WEEK IN DETROIT – and every company will profit by *making sure* its design-responsible executives and engineers have this once-a-year chance to see the latest and best in original equipment. There are three mornings and evenings of concurrent ASME Conference sessions waiting for you, too – all devoted to *"Designing for the Competitive Market"*. There is much for you in every one of the Conference's 24 major papers.

For hotel reservations write the Detroit Convention & Visitors Bureau. For other information contact:

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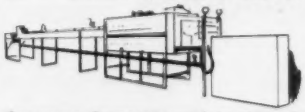
Circle No. **22** on Reader Service Card

Ed Johnson, Furnace Application Engineer, reports . . .

SINTERING
GOES SCIENTIFIC

The effective bonding of powder metal compacts is dependent on precise sintering temperatures, and the properly reactive furnace atmosphere for each temperature range. To assure optimum results at lowest cost, Hayes offers both the *right* furnace and the *right* atmosphere for any sintering operation, whether you're working with ferrous, nonferrous, or refractory metals; stainless steel compacts; or cermets. Hayes furnaces and atmospheres suitable for research, high-temperature, or production sintering, include:

Type BA-M Pusher "Pilot Plant" Furnace. Controlled atmosphere heating and cooling . . . straight-through design. Manual or automatic operation to 2150° F.



Conveyor Furnaces straight-through LAC and Humpback BAC — for continuous, automatic, sintering to 2100° F. Zone temp control. Burn-off sections. For stainless steel, etc.

Type BA High-Speed Pusher Furnace — wide-temperature-range furnace for sintering to 2350° F. Available with automatic, electro-hydraulic pusher system for constant time / temperature cycles.

Type M-Y High-Temperature Furnace for uniform heating of ceramic and metal compacts at temps over 3000° F. Economical — use with reducing atmospheres for close-control research or full-scale production.

Model HT/HV Vacuum Furnace for high vacuum (0.1 micron), high temperature (3000° F plus) sintering special refractory metals—titanium, zirconium, tungsten, etc. High-speed heating and cooling cycles. Cold wall design, low voltage elements.

Atmosphere Equipment . . . ammonia dissociators; endothermic, exothermic, nitrogen, forming gas generators; Molecu-Dryers for drying protective atmospheres to —100° F D.P. Designed for controlled, dependable operation.

Use Hayes experience and equipment to insure a "Results Guaranteed" solution to *your* heat treating or protective atmosphere problem—to improve your product, reduce spoilage, or speed up production. Write for details.

C. I. HAYES, INC.

819 WELLINGTON AVE. • CRANSTON 10, R. I.

LEADERS IN FURNACES

Established 1905

It Pays To See Hayes for metallurgical guidance, lab facilities, furnaces, atmosphere generators, gas and liquid dryers, pHayes-master (TM) control units.

Circle No. **33** on Reader Service Card

new products & developments

Continued from page 15

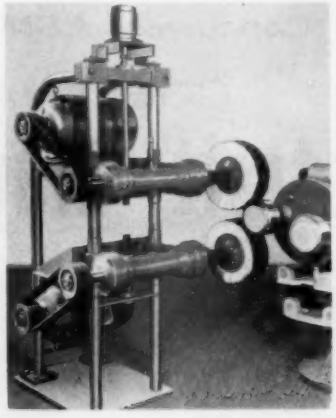
2500-pound zinc pigs

THE NEW JERSEY ZINC CO.—Large 2500-pound zinc pigs for large tonnage consumers are designed with legs and wings for easy transportation. Holes are also provided for crane-hoist lifting.

Circle No. **238** on Reader Service Card

Dual spindle lathe

MURRAY-WAY CORP.—With this dual spindle lathe the company claims that you can polish, buff,



deburr and do brushing jobs in half the normal time. The lathe has two separate motor-driven spindle assemblies mounted on one sturdy base.

Circle No. **239** on Reader Service Card

Heating element

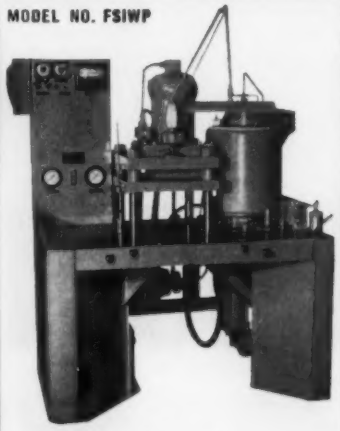
NORTON CO.—Super Hot Rod is an improved non-metallic silicon carbidemolybdenum disilicide heating element for furnaces. It gives longer life and raises the maximum operating temperatures about 15% without losing its long life properties, the company said. The new rod is tubular and will operate in temperatures to 1700°C. without requiring a protective atmosphere.

Circle No. **240** on Reader Service Card

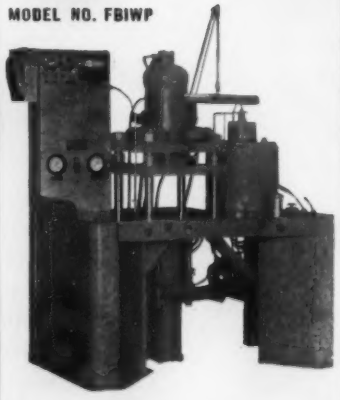
more New Products on page 63

NEW
WAX INJECTORS
3½ lb. CAPACITY ON STANDARD MODELS

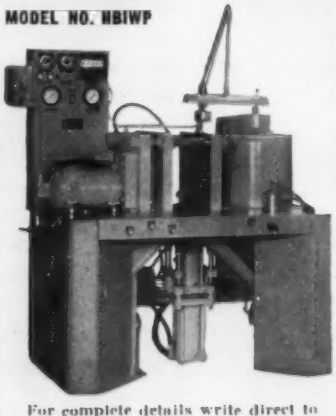
MODEL NO. FSIWP



MODEL NO. FBIWP



MODEL NO. HBIWP



For complete details write direct to Leyden Hydraulics

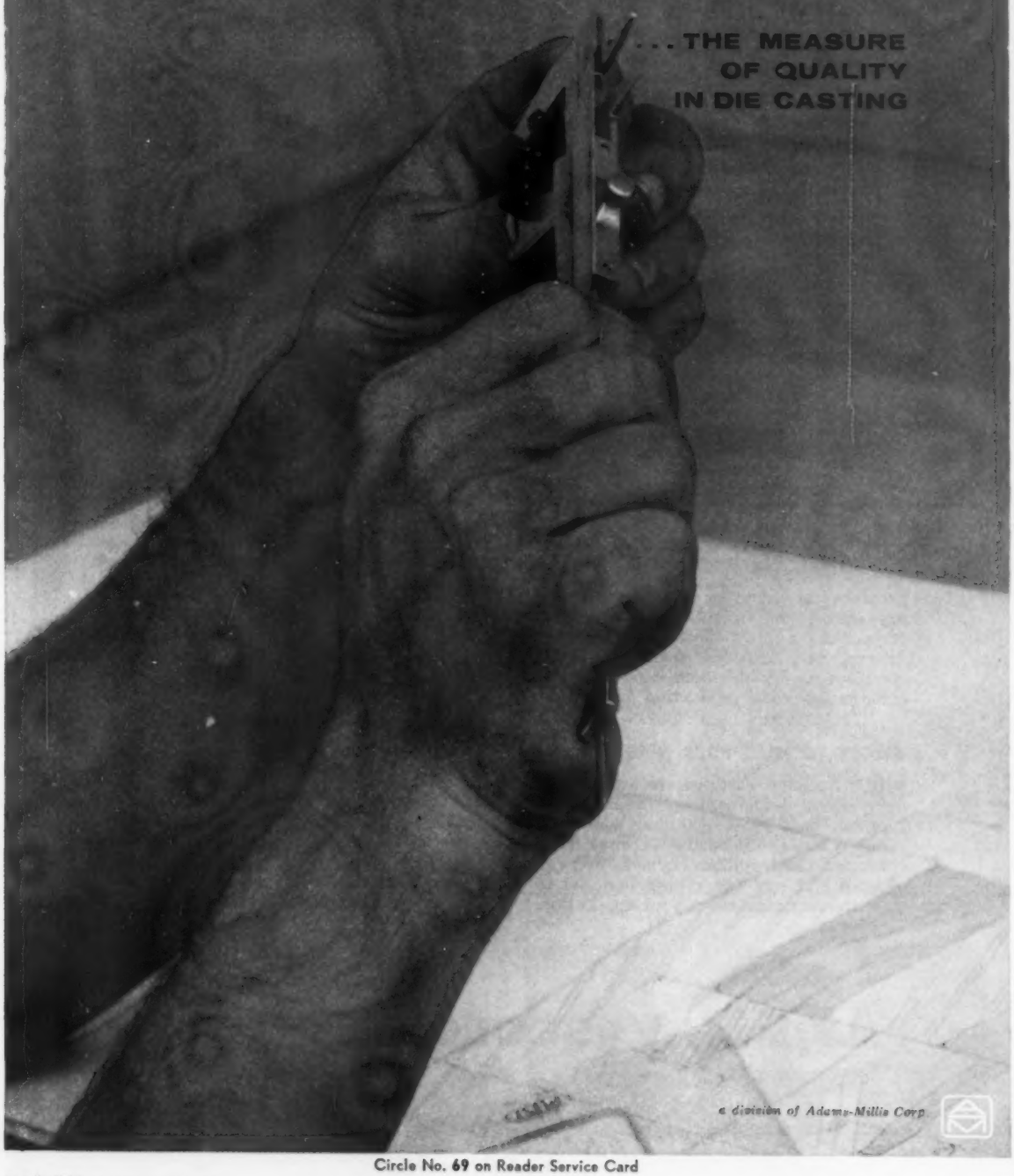
Any Type or Size Unit Built to Your Specifications.

LEYDEN HYDRAULICS, INC.

1800 North River Rd. • Melrose Park, Ill.

Solving intricate die casting problems is becoming a habit at Southern Die Casting & Engineering. Skilled and experienced management has joined hands with technical and theoretical research to develop new and better die casting techniques. One such industry advancement is the revolutionary new VIBROCAST process for increasing tensile strength in die cast products. Many of the nation's leading companies are benefiting from these designing and engineering services. You can too . . . For more information write or call today!

SOUTHERN DIE CASTING & ENGINEERING 206 Albertson Rd., High Point, N. C.



Circle No. 69 on Reader Service Card

V-R INVESTMENT CASTINGS...

DESIGN FLEXIBILITY . . .

provides cost savings by eliminating secondary operations. Irregular surface curvatures, thick and thin sections and shaped internal and external surfaces provide complete design freedom — no need to compromise with production limitations.

ALLOYS TO MEET YOUR NEEDS . . .

V-R investment castings are available in many alloys — such as a cobalt-chromium-tungsten cast alloy, 300 and 400 series stainless steels, ASI 8620 steel, low carbon steels and the beryllium coppers. V-R can develop and cast the proper material to meet the requirements of your application.

CLOSE TOLERANCES ON INTRICATE PARTS . . .

V-R specializes in casting *small* parts — often too small and intricate to be machined economically. Uniform, close tolerances are held throughout the entire production quantity.

METALLURGICAL KNOWLEDGE AND ENGINEERING SERVICE . . .

V-R metallurgists will be glad to study your application and recommend the proper alloy for your parts. Just send us the details of your problem including parts drawings and the requirements for resistance to heat, corrosion and wear.

V-R VASCOLOY-RAMET

CREATING THE METALS THAT SHAPE THE FUTURE

860 MARKET ST. WAUKEGAN, ILLINOIS

I-736 R

Circle No. **78** on Reader Service Card

news of industry & associations *activities of people, companies & groups in the precision metal molding industries*

promotions & changes

Harbison-Walker Refractories Co.—*Earl A. Garber* has been named chairman of the board, and will continue as chief executive officer, while *A. Brent Wilson* has been named president.

Alloys & Chemical Corp.—*Thomas H. Ginsburg* has been appointed vice president-plant manager and will administer the manufacturing operations at the Cleveland plant. *Alfred S. Dubinsky* has been appointed vice president-raw material purchasing.

Detroit Mold Engineering Co.—*Richard Hill* is now sales representative for the firm in western New York state and western Pennsylvania.

WaiMet Alloys Co.—*Roger F. Waindle*, president of WaiMet, has been elected president-board chairman of the Michigan Business and Defense Services Administration Executive Reserve.

Aluminum and Magnesium, Inc.—*Nick W. Cox* will represent the company in sales throughout Wisconsin and the Chicago, Minneapolis, St. Paul area.

Doehler-Jarvis Div., National Lead Co.—at the Pottstown, Pa., plant, *James R. McClurken, Jr.* has been named assistant plant manager; *P. William Marshall* has been made superintendent of the aluminum division; and *Warren H. Guldin* has been designated general foreman of the zinc division.

more on page 84

AZI has a new Detroit address

American Zinc Institute has moved its Detroit headquarters to new and expanded facilities, situated at 638 New Center Building, Detroit 2, Michigan.

According to John L. Kimberley, AZI's executive vice president, the new installation will permit the Institute to serve both its members and the automotive and allied industries in the area better.

Glidden expands in powder metal field

In a move to expand its operations in the metal powders field, The Glidden Company has purchased the assets of the metals division of The Crane Company of Johnstown, Pa.

The acquisition was effective February 1. The new facilities is a part of the metals department of Glidden's Chemicals Division. Among the major products of the Johnstown operation are electrolytic and reduced iron powder and electrolytic vacuum melting stock.

In addition to its ferrous products the Johnstown facilities produce nickel, manganese, silicon and other special powders. The iron powders involved in the acquisition are used primarily by the steel industry in making specialty alloys and by fabricators in the pressure molding of precision parts such as gears, bushings, and bearings.

Iron powder division emerges

KARIAN

Alan Wood Steel Co. announced the formation of an iron powder division. George G. Karian, formerly iron powder sales manager, has been named general manager of this division with responsibility for production and sales.

Schneier, Jr. is president

SCHNEIER, JR.

The Board of Directors of Advance Pressure Castings Corp. has named Alfred Schneier, Jr. president of the company. Alfred Schneier, Sr. has been elevated to chairman of the board. Inaccurate information was given in the March 1961 issue.

more Industry News on page 86

GARBER

WILSON

GINSBURG

DUBINSKY

HILL

WAINDLE

ONLY FROM REYNOLDS...

TENS® 50

with the HIGHEST STRENGTH/WEIGHT RATIO OF ANY ALUMINUM CASTING ALLOY

Check these characteristics of TENS 50 (named for its ultimate strength of 50,000 PSI) against your casting requirements:

- **Highest strength to weight ratio of any aluminum casting alloy for sand, permanent mold or investment casting.**
- **Properties comparable to medium strength aluminum forgings.**
- **Outstanding corrosion resistance.**
- **Easy to weld.**
- **Excellent fluidity and castability—not "hot short".**
- **Requires no changes in conventional melting, casting, gating, and heat treating practices.**
- **Complete scrap utilization—gates, riser and scrap castings can be remelted.**

Typical Sand and Permanent Mold "T6" Heat Treatment Properties		
	Sand	Permanent Mold
Tensile Strength	47,000	53,000
*Yield Strength	38,000	43,000
Elongation	4%	7%

*Engineers: Note outstanding yield strength.

Reynolds Metals Company and their Distributors are the only source for TENS 50. For complete information on this strong and ductile aluminum casting alloy, write for TENS 50 brochure to *Reynolds Metals Company, P. O. Box 2346-FP, Richmond 18, Virginia.*

TENS 50 is a trademark of Navan Products, Inc., a division of North American Aviation, Inc.

REYNOLDS ALUMINUM

Watch Reynolds TV show
"Harrigan & Son", Fridays; also
"All Star Golf", Saturdays—ABC-TV

Circle No. 64 on Reader Service Card

Brown Boveri three-ton line-frequency coreless induction meltdown furnace

PREVIEW: FOUNDRY OF THE FUTURE

Early in 1962, in a German plant, *a single operator* at a central console will supervise the "punchcard" operation of an entire gray-iron foundry . . . including charging and meltdown in nine 5½-ton induction furnaces; the automatic alloying, analysis and correction of the melt; and the automated casting strip. The furnaces and automation equipment are now being engineered and built by Brown Boveri.

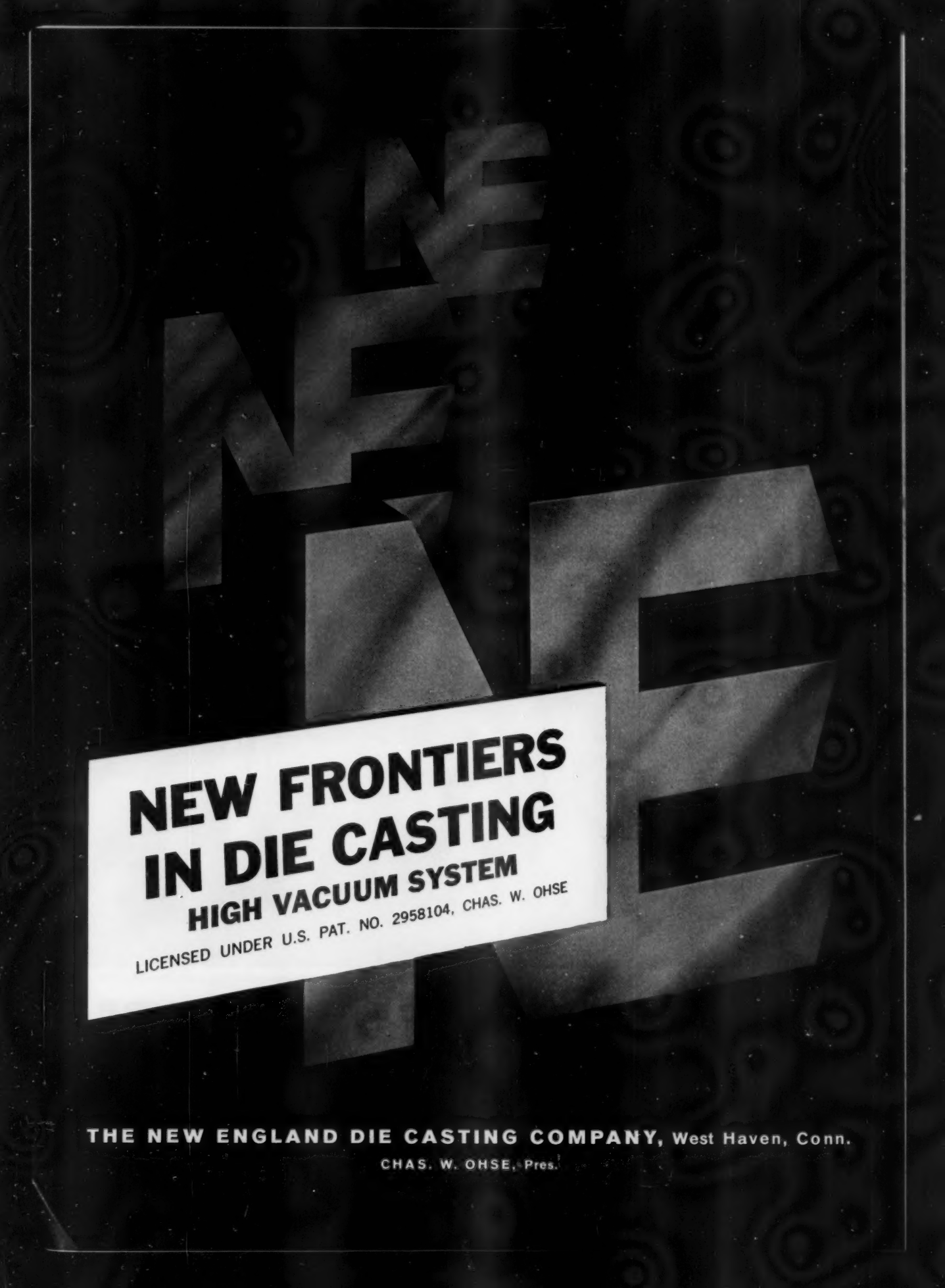
The furnaces will be Brown Boveri line-frequency coreless induction units similar to that in the photo. Here is why this furnace is rewriting foundry technology:

It produces superior, more uniform metal. It is clean and cool to operate. It is simple, rugged and foolproof, thus ideally suited to automatic control. It is low in cost. (For example: the nine-furnace set-up *including all controls* will cost substantially less than cupola-and-induction furnace duplex equipment.) And the furnace design has been proved by *hundreds* of installations in the U. S. and throughout the world . . . with a total capacity greater than that of any other manufacturer.

Furnaces are available in all sizes . . . for melting, holding or superheating . . . for any metal. Write for application study. Address Brown Boveri Corp., Dept. 3, 19 Rector St., New York 6, N.Y.

BROWN BOVERI

Circle 16 on Reader Service Card


NEW FRONTIERS
IN DIE CASTING
HIGH VACUUM SYSTEM
LICENSED UNDER U.S. PAT. NO. 2958104, CHAS. W. OHSE
THE NEW ENGLAND DIE CASTING COMPANY, West Haven, Conn.
CHAS. W. OHSE, Pres.

MAKE BETTER USE OF POWDER METALLURGY PARTS

. . . advises MPIF design seminar

DESIGNERS GOT SOME USEFUL POINTERS on ways to use powder metallurgy parts more effectively in their products during the recent SAE meeting in Detroit. A panel from the Metal Powder Industries Federation led a seminar, attended by more than 500 engineers, in a discussion of the advantages of components made by powder metallurgy techniques.

While lower cost is an important element in every choice of materials, the group was told of many other advantages to be gained, including . . .

Improved performance
Preferred configurations
Dependable properties
Competitive design advantages
Wide range of properties
Solutions for difficult design problems
Reduced capital tie-up in equipment

Not all of these can necessarily be secured in all cases, but the consensus of panellists who led the discussion was that "while the metalworking industry has exploited powder metallurgy for working more and better economies into manufactured products, industry has not taken full advantage of the unique properties of powder metallurgy."

In the words of one panellist, "Cost reduction programs, although most important, can sometimes be overdone and result in a decrease in profits. Proper use of the products of the powder metallurgy industry can increase your profits even though the initial per piece costs may sometimes be higher."

Get a better competitive position

How increased unit costs can actually mean greater profits through a better competitive position was shown by R. B. Thomson, product manager, United States Graphite Co., division of the Wickes Corp.

For illustration, he described a hardened and ground steel roller, a common part of many machines. Usually it's made from cold rolled stock, fully machined and hardened and then ground.

"The metal working industry is not fully exploiting all of the unique advantages and properties of our material."

THOMSON

Made from metal powders, the roller can have a comparable hardness and better wear resistance than the cold rolled part. It will meet the same tolerances as the machined roller and will have the unique, added property of self lubrication. While the powder metallurgy part may cost a penny or two more, it can easily sell for from 5¢ to 10¢ per

"With improved control of our base materials and processing, powder metallurgy gives improved performance over those parts produced from other materials."

BLUE

unit more due to the advantages of self lubrication. That's one competitive advantage.

Or suppose that corrosion resistance is important, Mr. Thomson pointed out. By a simple steam treatment an oxide surface can be formed which is hard, wear resistant, and amply resists normal atmospheric corrosion, even in an industrial atmosphere. There's competitive advantage number two and at only a fraction of a cent increase in unit cost. Then don't forget that the roller can be made to very precise tolerances if it can bear the added cost. This frees your machine tools from both rough and finish machining. It also takes part of the load off of the heat-treating department.

Get improved performance

"Engineers are constantly looking for ways to improve existing products," Roy Blue, chief engineer of the Amplex Div., Chrysler Corp. told the seminar. Powder metallurgy has learned how to control precisely its base materials, manufacturing methods have improved, and with the advances made in press design, it is now possible to make parts which have all of the desirable mechanical properties, the most functional geometry, and usually the lowest cost.

For example, the transmission kick-down lever, figure 1, used to be made from an aluminum extrusion. It operates at loads between 150 and 300 pounds. This means unit pressures of 7000 psi.

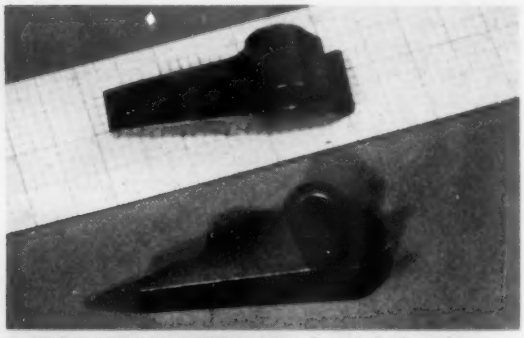
"Powder metallurgy parts which have replaced it have been operated on test with 20% overload for over a million cycles with no failure, Mr. Blue said. These parts have better resistance to brinelling, improved wear resistance, better surface finish and no burrs. They are made to final dimensions, including the hole. Here's a better functioning part as a result of powder metallurgy."

The transmission clutch pressure plate lever shown in figure 2 is another case of improved performance. The lever was originally designed as a straight section of steel. It did not provide constant pressure when the clutch engaged. Through the use of powder metallurgy we made a better shape. It gave uniform pressure on the clutch plate.

"We have learned to control densities, porosities, strengths and electrical properties of our materials."

KICK

In this case, tooling was rapid. Parts were delivered to production in less than one week. There was a cost saving on the part and a plus of better wear characteristics and better surface finish.



1. HIGH STRESS OPERATION doesn't bother this powdered iron transmission kick-down lever. Unit pressures up to 7000 psi are easily handled.

2. BETTER OPERATING CHARACTERISTICS were gotten when a powdered iron clutch pressure plate lever was used instead of a machined steel part.

Lower capital investment

If you decide not to use powder metallurgy parts you may have to buy new machine tools, it was indicated. In large manufacturing plants this may not be the most serious consideration, but in smaller plants it can mean the difference between making a product or not.

Even when the initial tooling cost for powder metallurgy is high, it is frequently far better to pay for tooling than to invest in new machines. "Don't forget, in most cases money saved by not making a capital investment is reflected as profit," the audience was reminded.

Great savings can come when a powder metallurgy part is substituted for a sand casting. Castings generally require overall machining. The shapes are often complex so that special machines must be used. Even when the parts are relatively large, from two to three pounds, many fabricators of

metal powder parts can make them and show both a direct part cost saving and a reduction in capital investment in machine tools.

Lower manufacturing costs

Insight was given into ways to exploit the ability of the powder metallurgist, to cut the cost of manu-

HELSEL

"I don't think there is a process available wherein you get as much for your dollar as you do in the powdered metal field."

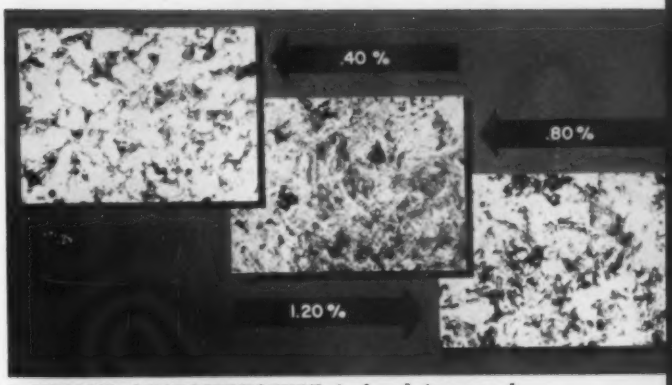
facturing a product. Take a simple operation such as pressing a bushing into a hole in a housing. Generally the least expensive powder metallurgy bearing material is press fitted into the housing. Reaming and boring give precision tolerances. Even though a precision, self-lubricating, powder metallurgy bushing, pressed into an accurately positioned hole, will cost a little more than the bearing "blank" previously used, money is saved by eliminating the extra machinery operation. As an added benefit, the bushing is self lubricating so there is no problem of oil supply. How great the saving can be and how much better a product is produced, was illustrated by a windshield wiper motor with solid metal bushings, in which an oil reservoir has to be provided and oil channels to each bushing machined.

Get a better product

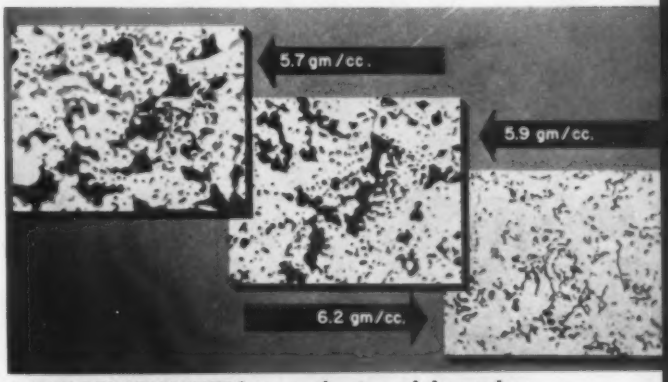
Better products are constantly coming from the powder metallurgists. This was pointed out by Robert J. Kick, sales engineer, Delco-Moraine Div., General Motors Corp. "There are many cases," he reported, "where a superior product can be made by using a powder metallurgy part. In the past, the mechanical properties of the parts were not good enough. Today we know the carbon absorption of our powders and carbon potential in the furnace gas. We can make parts with very precise carbon content." This is shown clearly in figure 3. The three carbon ranges are, of course, about .40, .80, and 1.20. Each fills a specific application.

"Low alloy irons and steels have been made into high tensile strength materials."

PETTIBONE



3. NORMAL MICROSTRUCTURE is found in properly made powdered steel parts.



4. THE RELATIONSHIP between the size and the number of voids and the density of a powdered iron part shows clearly in photomicrographs.

"In addition to carbon control," Mr. Kick said, "we have good control of density (see figure 4), porosity, strength, and electrical properties of our materials. This ability has resulted in guaranteed properties which the suppliers can furnish.

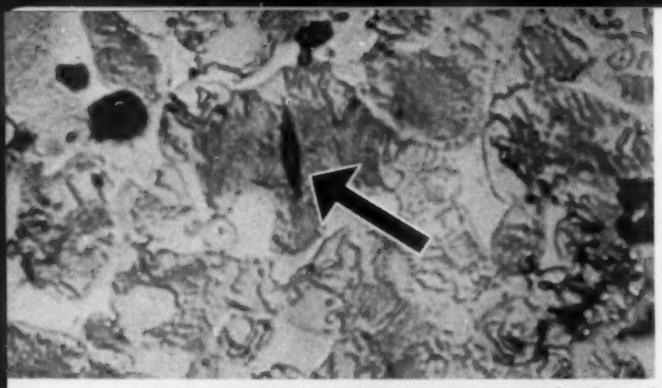
Difficult designs are practical

Just a few years ago it was considered impossible to make very large parts or parts with complex contours. This has changed according to Jess Helsel, president of Ferro Powdered Metals, Inc. Today many shops are making parts which weigh over two pounds and make them on a regular production basis. "Further," Helsel said, "improvements in molding presses let us make parts which were completely impossible only a few years ago.

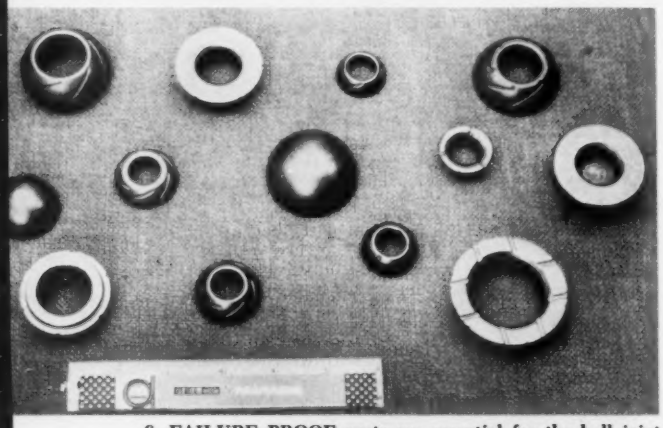
"The buyer should remember, however, that not all fabricators can do all jobs. There has been some trend to specialization. A bit of shopping around may be needed to find the shop which can make your part."

High strength materials

"High strength materials made from metal powders used to be something to be prayed for, but



5. MEASUREMENT OF HARDNESS of powdered metal parts is best done by micro hardness. The diamond indent shown is entirely on a single grain.



6. FAILURE PROOF parts are essential for the ball joint assembly of an automobile. Powdered iron parts serve well in this application.

seldom gotten," according to Robert Pettibone, general manager, Powered Metals Div., Eaton Mfg. Co. "Today, low alloy steel powders are available which give tensile strengths of 75,000 to 100,000 psi without going to unrealistic high densities. Then too, small additions of aluminum and nickel have improved hardenability. Now we make intake valve inserts for automobile engines.

"In the same strength ranges parts with high density, around 7.0 g/cc, are commonly made. Parts in this density range can be made with phenomenal dimensional control.

"Case hardening by carburizing and carbonitriding is quite successful and commonplace. A well defined case is gotten with the usual tough core.

"Where moderate strength and high elongation are needed, copper infiltrated parts with tensile strengths around 60,000 psi and 30% elongation can be made. With the addition of small amounts of carbon, the infiltrated material will have about 100,000 psi tensile and by heat treatment the strength can be raised to about 180,000 psi.

"These infiltrated parts have densities from 7.1 to 7.6 g/cc. They are pressure tight, are excellent for plating, can be welded and brazed, and with no surface protection show good resistance to corrosion in high humidity environments.

"We can also make parts in various stainless steels. Type 316 is the most common and parts made from it have a tensile strength around 60,000 psi. However, the corrosion resistance is not as good as wrought stock."

A lively question and answer period raised many questions which are of concern to designers. Typical of the questions asked were:

How is hardness of a powdered metal part determined?

The best, and possibly the only accurate, way to measure hardness is with a micro-hardness tester. If one of the more usual methods is employed a false reading will be gotten because the ball indenter measures particle hardness as well as possible collapse due to the porosity of the part. The readings from a standard hardness measuring devise is, therefore, almost always low. A typical micro-hardness measurement is shown in figure 5. The diamond indentation is entirely on a single particle and the load is light enough to prevent motion.

Can surface finish, in micro-inches, be specified for a powdered metal part?

Measurement of surface finish is difficult. You have to be able to tell the difference between real surface roughness and the effect of porosity as indicated by the measuring instrument. Optical comparison is about the best method, provided comparison is made on solid particles.

Can powdered metal parts be used where maximum safety is required?

Yes, they can. For example, the parts shown in figure 6 are half balls for the ball joint suspension of today's automobile. Obviously, these parts must meet the highest safety standards. They are made in low carbon steel, a little above normal density, and carbonitrided for high surface hardness. They retain their softer, tough core for high impact resistance. Further, they are made to high precision tolerances.

We are interested in using powdered metal dies for vacuum forming of plastics. Can we get parts about 43" x 15" x 3" thick?

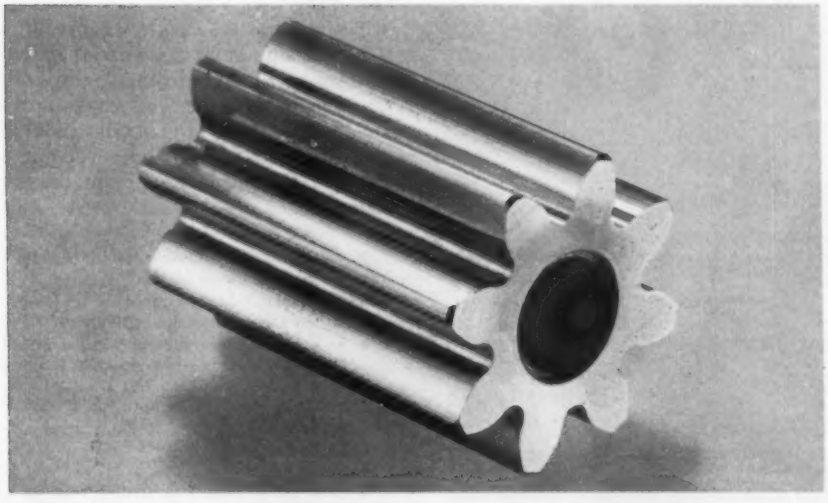
That will depend entirely on the press equipment available. With about 645 sq. in. area and using 30 tons per sq. in. it is doubtful if anyone has a press of enough capacity. However, if you can stand a fairly porous part it is possible to loose sinter powder and get a part which will have a shape but not very high density.

Other questions and answers covered a broad field of properties, materials, processes, and recommendations. The collective experience of the panellists, all of whom have had many years in production of powder metallurgy parts, provided the audience with answers which were both accurate and realistic.

The success of these seminars has led to the planning of others in key metal working areas.

to get the part you want . . .

CLEAN UP YOUR SPECIFICATIONS



TO GET THE PART YOU WANT, be sure that your specifications are clear, concise, and definite.

As an example, take an oil pump gear. Almost every metal powder fabricator makes these gears, but not all of them do the intended job as well as they should. And it isn't the fault of the fabricator. In almost every case the gear was made to specifications. Where was the fault? Sloppy specifications.

The oil pump gear shown has to do a specific job. If there's too much leakage backwards the required pressure can't be maintained and vital engine parts will not get the amount of lubrication they need.

A drawing gives only a small part of the information the fabricator needs. In the case of a gear, for example, more complete data would include the information listed in Table I. Use table II as a check list to make certain all the necessary information is included in the blueprint.

TABLE I—DESCRIPTION OF THE PART

Industry	Automotive
Material	Iron-Copper
Application	Aluminum Engine
Use	Main Oil Pump
Service Conditions	Light Shock, Continuous Wear
Physical Properties	36,000 psi Tensile, 1% Elongation
Hardness	65 to 75 Rockwell F
Secondary Operations	Straddle Mill Length to 1.921-1/923

TABLE II—GEAR DATA

No. of Teeth
Diametral Pitch
Pressure Angle
Outside Diameter
Pitch Diameter
Root Diameter
Base Circle Diameter
Root Radius
Diameter Roll Pin
Dimension Over Rolls

EXTRUSIONS AND DIE CASTINGS MAKE RUGGED CAMERA

MINIMUM WEIGHT, MAXIMUM STRENGTH. That's why the main structural components of Graflex, Inc.'s Super Graphic camera are aluminum extrusions and aluminum and magnesium die castings.

Used around the world, the camera must be lightweight for easy handling, and strong to withstand abuse. It has to take the sub-zero temperatures of the Antartic and the heat and humidity of the tropics. It has to be rugged to withstand a lifetime of hard use and abuse by the professional photographer. The camera might see action in hurricanes, blizzards, or war, and it probably will be covered with mud more than once.

THE ALUMINUM EXTRUSIONS

The body

The wrap-around body, (figure 1), is extruded in 6063 T42 aluminum to normal tolerances of ±0.005. Besides housing the camera, the body carries the range finder housing, and serves as a means to attach the bed hinge, the handle and flash gun brackets, the bellows, and the revolving back. Graflex engineers chose an aluminum extrusion for these reasons:

- Can easily be formed to the body shape.
- Needs only minor machining.
- The formed frame can easily be joined by spot welding an aluminum plate at the joint.
- Side beads can be designed in.
  Note: The beads add rigidity to the housing and serve as a means to attach the back and bellows. Also, it makes it possible to butt the leather covering up to the bead.
- Light weight.
- Fine appearance.
- Low set-up cost. The tooling cost for the body extrusion was approximately $1,000. This included the extrusion die, the forming equipment tooling, and jigs and fixtures.

After extruding and cutting to length, the frame is formed by rolling. This guarantees that the width and the beads will remain as extruded. The formed frame is joined at the bottom by using a 1/16" thick aluminum reinforcing plate (figure 1), spot welded in six places. Next all critical holes, such as those for the bed braces, are drilled.

The front of the housing is buffed to grain the aluminum, and then is clear anodized. Black primer is applied on the interior surfaces to ready the housing for assembly.

The extruded yoke

The bed yoke (figure 2) uses an extrusion to get only the basic shape of a part. The precision tolerances required for the infinity stop and locking mechanism grooves could not be gotten as-extruded. To machine the yoke from bar stock would have made the costs excessive. The camera standard attaches to the yoke and must move forward and backward smoothly. Movement is achieved by rotating a knob, which brings into focus with the film plane, any lens, from 65 millimeters to 15".

The Aluminum Company of America extrudes the shapes in 24S-T aluminum. Graflex cuts them to

length and the center hole is punched out to reduce weight without sacrificing strength. Then, in two steps, broaches the grooves. The surface where the teeth are to be cut is milled. Two fixtures on the same mill cut both sets of teeth in one operation. Last, a slope is milled on the end of the housing. This make it easy for the front standard to slide onto the yoke.

Before the teeth are cut, the yoke is barrel finished. A Lea finish is applied along the length of the part after a flexible wheel has broken the sharp edges left from the broaching operation. The yoke is then clear anodized.

THE MAGNESIUM DIE CASTING

The primary reason for using magnesium die castings in the Super Graphic is for light weight. Yet, Graflex engineers list other advantages.

- Good mechanical properties—On an equal basis with other metals, magnesium gives superior strength and increased rigidity.
- Outstanding Machinability—Magnesium is the easiest structural metal to machine.
- Cast to close tolerances—Magnesium can be cast to closer tolerances and thinner walls than aluminum and close to those of zinc. All conventional methods of finishing can be used.
- Low cost.

Even though the volume of production does not compare with mass produced consumer items, and may not seem to warrant die casting, it is the least expensive way to make these parts.

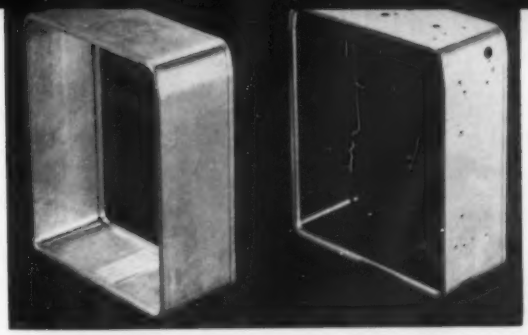
The bed

The bed (figure 3) is die cast is ASTM-1394-58, Alloy AZ91 A or B magnesium by Litemetal Dicast, Inc. On previous models, the bed was made of formed aluminum, requiring many extras to complete the part. By redesigning for a magnesium die casting, all of the extras could be incorporated. In addition, ribs could be designed in to allow the leather covering to butt against the rib instead of having to wrap it around the edge. Also, for appearance, a crowing could be designed and cast in. The only machining is the notches for the hinge knuckles and to drill and tap the holes.

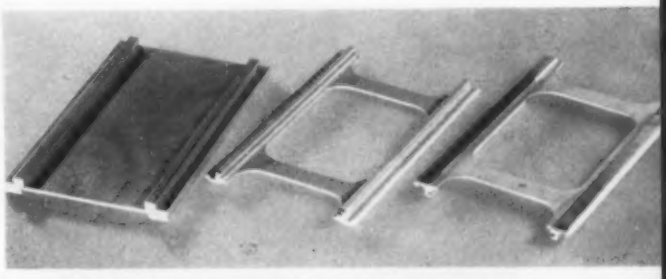
The finish on the bed casting is Dow Chemical Treatment No. 1 applied immediately after casting and again after machining. (Dow Treatment No. 1 is a chrome pickle that has good paint base qaulities. It is often used to protect parts during shipment and storage. Its etching action only removes about 0.0001-0.0003″ per surface on die castings.) The bed casting is barrel finished to remove burrs and smooth the surfaces. Then a black zinc chromate primer paint coat is applied, followed by a semi-gloss black enamel. On the back face of the bed a black wrinkle lacquer is applied. The front is leather covered.

The back

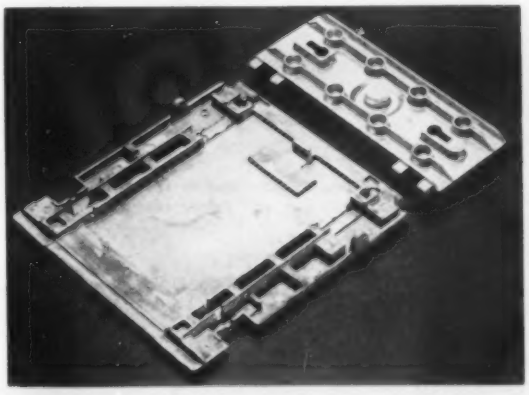
Three magnesium die castings in ASTM B94-58, Alloy AZ91 A or B make up the back of the camera:



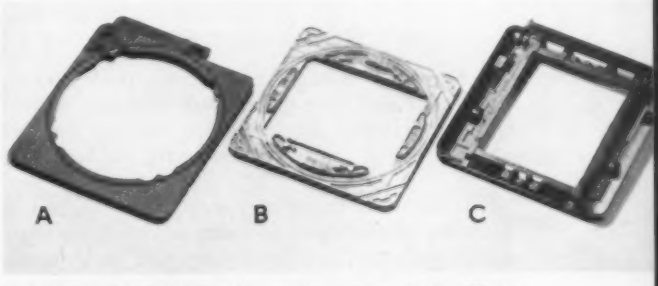
1. A FLAT EXTRUSION is cut to length, roll formed to the rectangular shape and the joint welded to form the camera body.



2. A SOLID SHAPE is extruded to minimize the amount of machining needed to make the camera yoke.

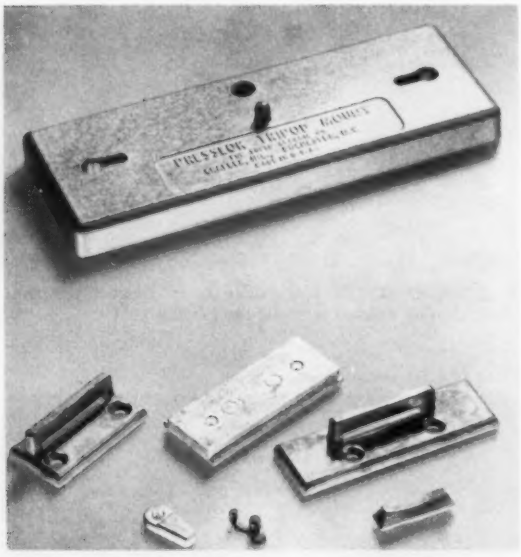


3. EXTREME COMPLEXITY describes the bed shape. With magnesium die castings almost all of the very difficult machining is eliminated.



4. THREE CASTINGS make up the camera back. All are magnesium and all are made to almost final size. Only minor machining is needed.

5. A RANGE FINDER body must be accurate to properly mount the optical components. That's why an aluminum die casting is used.



6. MANY MINOR camera components are die cast in zinc. Strength, easy finishability, and minor machining are why they're used.

7. ADEQUATE STRENGTH, good finishability, low manufacturing cost are why the lock lever is an infiltrated iron powder metal part.

The Stationary Back, The Revolving Back, and the Focusing Panel. The general wall thickness of these castings is 0.062". Their outside contours must be as nearly alike as is consistent with the best casting practice.

The Focusing Panel (figure 4a) supports and locates the ground glass focusing screen. Four registration pads are machined from cast pads on the glass side. Then ledges locating the glass are machined from the four register pads. The casting is barrel finished to remove burrs. Finish is the same as the other two castings except that the black wrinkle coat is applied only to the rear face.

After barrel finishing, to remove burrs and clean up the castings, a zinc chromate black primer is applied. Then black enamel is put on the rear face and edges. No enamel is allowed in the tapped holes, the cavity or the groover.

The Revolving Back (figure 4b) carries the film-holding accessories either by spring pressure or clamps. The only machining is drilling and tapping. Finishing is the same as the stationary back except that a black wrinkle is applied only on the back.

The Stationary Back (figure 4c) supports the revolving back and fits snugly into the extruded frame. The I.D. of the casting is machined to provide proper clearance for the revolving back. The casting is given Dow Chemical Treatment No. 1 after casting and again after machining.

THE ALUMINUM DIE CASTINGS

The rangefinder

The Rangefinder Housing (figure 5) is die cast in ASTM B-85, Alloy S12A aluminum by the Dollin Corp. The ledges that the range finder rides on have to be machined to provide square and sharp corners. The casting is given a black anodic finish, a black primer, and then a black lacquer coat on the face. The raised, cast-in company name is machined to bare the metal and provide an attractive name plate.

The track

The track on which the lens is stored is also cast in aluminum. It fits inside the frame and serves as a means to hinge the bed. Two cast-in holes, are designed to accept the Presslok Tripod Mount. The center hole is used to mount the camera on a standard tripod.

After barrel finishing, the casting is given a black anodic finish and a black primer coat. Only machining required is to drill the hinge holes and the center hole, and to mill the hinge knuckles.

Other die castings used on the Super Graphic are the zinc die cast handle lugs (figure 6) which are used both for the adjustable carrying strap and for the flash gun mounts. These are copper-nickel decorative chromium plated. Before plating they are sand blasted for a matte finish.

Other zinc die castings are the two Lensboard Release Slides (figure 6).

THE SINTERING

The lock lever

The front standard lock lever (figure 7) is sintered in copper infiltrated iron powder, 80% iron, 20% copper, by Reese Metal Products Co. The powder metal part replaces an assembly of two-part punch press pieces used on the previous camera, and two steel balls that were necessary for the lock to function. In locking, the raised portion has to climb up and over a cylindrical surface and wedge the two parts together. This is a hard sliding action but the part stands up well. The lever is ball burnished and then chromium plated to ready it for use.

Consider these factors when you . . .

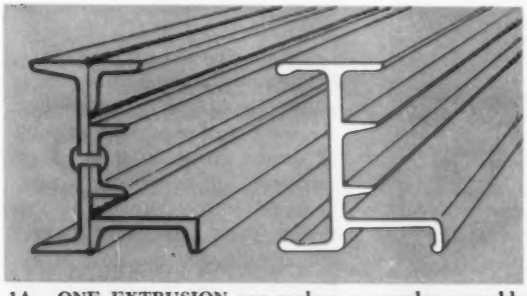
DESIGN WITH ALUMINUM EXTRUSIONS

- ***simplified assembly*** 35
- ***die costs*** 37
- ***section thickness*** 37
- ***piece length*** 38
- ***types of selection*** 38
- ***D factor*** 38
- ***shape vs cost*** 38
- ***tolerances*** 40
- ***dimensioning*** 40
- ***joints and joining*** 41
- ***wide extrusions*** 42
- ***finishing*** 42

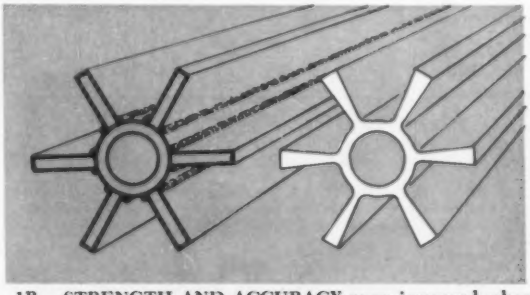
TOOLING COSTS for aluminum extrusions are generally so low that it doesn't pay to "make-do" with fabricated shapes joined together. If, however, an assembly of parts is necessary, take a long look to see if several components can be combined so that assembly operations are reduced.

SIMPLIFIED ASSEMBLY

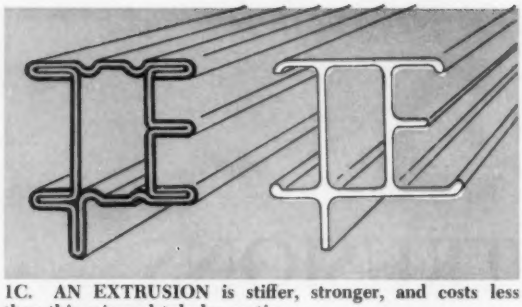
Some examples of how a single extrusion can replace a group of separate parts are shown in figure 1. Frequently too, variable section thickness is desirable for rigidity and/or strength. This is often difficult and sometimes impossible if the part is fabricated by any method other than extrusion. For example, figure 2 shows how a single hollow extrusion has replaced roll-formed sheet. Joining has been eliminated and where added strength and rigidity are needed the sec-



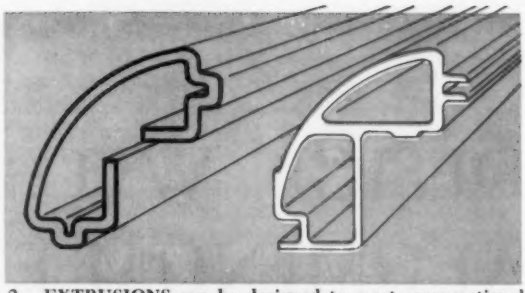
1A. ONE EXTRUSION can replace a complex assembly of rolled structural steel shapes.



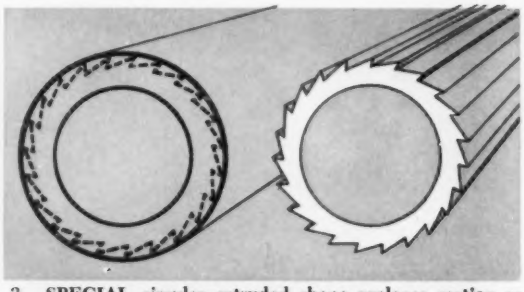
1B. STRENGTH AND ACCURACY were improved when this welded assembly was replaced by an extrusion.



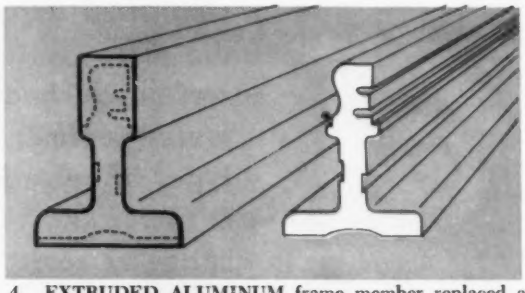
1C. AN EXTRUSION is stiffer, stronger, and costs less than this crimped tubular section.



2. EXTRUSIONS can be designed to meet cross-sectional requirements better than roll-formed sheet.



3. SPECIAL circular extruded shape replaces section requiring expensive machining from bar stock.



4. EXTRUDED ALUMINUM frame member replaced a heavily machined rolled shape.

tion thickness has been increased. Also, added stiffness has been gotten by including a web to reinforce the curved surface.

Other ways in which the use of an extruded section can save costs are when long sections must be machined from rod, bar, or rolled stock. An extruded shape which replaced a machined pipe is illustrated in figure 3. If sharp corners are not required the piece may be used as-extruded. However, the minimum commercial tolerance for corner and fillet radii is 1/64". A sharper corner would still require some machining, but obviously a great deal less than to hog the shape out of pipe. In another case where a rolled shape was used as the starting stock and then machined, an extruded shape eliminated all of the machining, as shown in figure 4.

The maximum cross-sectional dimensions generally considered commercial are limited by the circumscribing circle. This is usually 12" in diameter. A few extruders have very large presses which can handle sections circumscribed by a 17" diameter circle. The circumscribing circle, incidentally, is the smallest circle which completely encloses a shape. This factor is important in design since the cost of an extrusion and the tooling are influenced by the diameter of this circle. There are other factors which influence the cost of extrusions which we will take up later.

TABLE I—MINIMUM THICKNESSES OF ALUMINUM EXTRUSIONS

Circumscribing Circle Diameter(2), Inches	MINIMUM THICKNESS, Inches(1)						
	Solid Extruded Shapes					Hollow Extruded Shapes	
	6063(4)	1100 3003 6061 6062	2014(3)	2024	7075	3003 6063	6061 6062
Under 2	.040	.050	.050	.040	.050	.050	.062
2 to under 3	.045	.050	.050	.050	.062	.062	.078
3 to under 4	.050	.050	.050	.063	.078	.078	.094
4 to under 5	.050	.063	.063	.078	.094	.094	.109
5 to under 6	.050	.063	.078	.094	.109	.....	.....
6 to under 7	.062	.078	.094	.109	.188	.....	.....
7 to under 8	.078	.094	.109	.125	.215	.....	.....
8 to under 10	.109	.109	.125	.188	.375	.....	.....
10 to 12	.156	.156	.188	.250	.437	.....	.....

NOTES:

(1) Applicable to mean thickness if unequal plus and minus tolerances are specified.

(2) The smallest circle that will completely enclose the shape. Minimum thickness less than indicated may be possible for some sections of shapes having a circumscribed circle diameter under 2".

(3) Minimum thickness of 2014-T6 is 0.125".

(4) Maximum thickness of 6063-T42 and 6063-T5 shapes is ½".

DIE COSTS

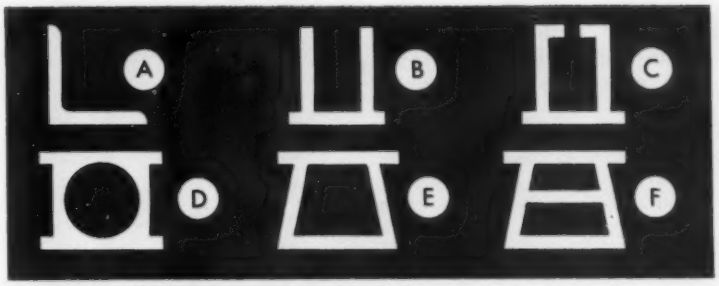
While we are on the subject of die costs it's worth while for the designer to know how his extruder figures tooling costs. If the circumscribing circle is 3" or less the die charge for a solid shape is about $125, for a 3" to 4" circle $160, and for a 4" to 5" circle $210. These figures may vary some from vendor to vendor, but are good average figures for tooling estimates. Obviously these charges do not cover the cost of the dies. They are simply a service charge. In some cases the vendor sets up a minimum order for the first twelve months after the die is put into production. If the purchaser equals, or exceeds, this minimum amount, the entire die charge is rebated.

In any event, the die remains the property of the vendor who guarantees to keep it in serviceable condition at all times. Should tooling wear or be broken, it is the responsibility of the vendor to replace it. This is, of course, a great contrast to other fabricating methods where the purchaser must pay the entire cost of tool making and must amortize it over the design life with no rebate.

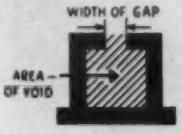
SECTION THICKNESS

The minimum section thickness, regardless of cross section, is about 0.040". This minimum varies with the diameter of the circumscribing circle and the alloy being extruded. Table I gives average minimum section thicknesses for different circle sizes and different alloys. Solid shapes can be extruded in thinner sections than hollows. For example, with a 3" circumscribing circle and extruding 6063 alloy, a solid can be extruded with 0.040" walls. A hollow of the same size and in the same alloy has a minimum wall section of 0.050".

On the other hand, the weight per foot of an extrusion is governed by the limits of the extrusion ratio. Normally this ratio



5. **TYPICAL EXAMPLES** of various types of extrusions.



6. **SEMI-HOLLOW**

TABLE II—TONGUE RATIO FOR VARIOUS GAP WIDTHS

Gap Width, W, Inch	Tongue Ratio, $R = \frac{A}{W^2}$
Less than .031	Over 1
.031 to .061	Over 2
.062 to .124	Over 3
.125 to .249	Over 4
.250 to .499	Over 5
.500 and greater	Over 6

Note: Tongue Ratios under those shown classify the part as a "Solid Extruded Shape." Minimum gap width that can be produced is .030 inch.

TABLE III—DIFFICULTY (D) FACTORS FOR EXTRUDED ALUMINUM SHAPES

Circumscribing Circle Diameter of Section, In Inches		DIFFICULTY FACTOR D				
		D-40	D-50	D-60	D-70	D-80
From	To (Not Incl.)	will apply if "f" Factor $\left(\frac{CP^2}{2A}\right)$ falls within values shown below:				
0	¾	1- 25	26- 35	36- 50	51- 75	Over 75
¾	1	1- 30	31- 50	51- 70	71- 100	Over 100
1	1½	1- 55	56- 85	86- 125	126- 180	Over 180
1½	2	1- 100	101- 145	146- 200	201- 285	Over 285
2	2½	1- 160	161- 210	211- 285	286- 390	Over 390
2½	3	1- 210	211- 275	276- 370	371- 495	Over 495
3	3½	1- 260	261- 340	341- 455	456- 605	Over 605
3½	4	1- 310	311- 410	411- 540	541- 710	Over 710
4	4½	1- 365	366- 475	476- 625	626- 820	Over 820
4½	5	1- 415	416- 540	541- 710	711- 925	Over 925
5	5½	1- 465	466- 605	606- 795	796-1030	Over 1030
5½	6	1- 520	521- 675	676- 880	881-1140	Over 1140
6	6½	1- 570	571- 740	741- 965	966-1245	Over 1245
6½	7	1- 625	626- 805	806-1050	1051-1355	Over 1355
7	8	1- 730	731- 940	941-1220	1221-1570	Over 1570
8	9	1- 830	831-1070	1071-1390	1391-1780	Over 1780
9	10	1- 935	936-1205	1206-1560	1561-1995	Over 1995
10	11	1-1040	1041-1335	1336-1730	1731-2210	Over 2210
11	12	1-1145	1146-1465	1466-1900	1901-2425	Over 2425

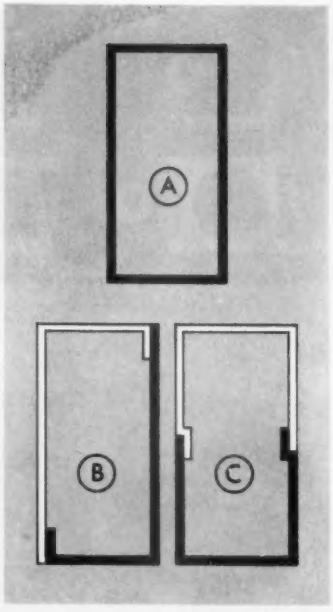
is not less than 16:1 nor more than 45:1. Within these limits, the weight per foot varies from less than one ounce to 20 pounds.

PIECE LENGTH

Where extrusions must be cut to specified lengths, the maximum extrudable length becomes important. For most mills 40′ is the maximum length. This is limited by heat treating facilities, weight per foot of the extrusion, and shipping facilities. With non-heat treatable alloys lengths up to 80′ can be extruded. The designer should, therefore, specify extrusion lengths which are exact multiples of the part length he needs, with due allowance, of course, for cutting losses. The vendor, in turn, will regulate his billet size to furnish the required lengths.

TYPES OF SELECTION

Aluminum extrusions are divided into three general classes: solids, semi-hollows, and hollows. Typical examples of each type are shown in figure 5. For a part with the same circumscribing circle, solid shapes are the least expensive, semi-hollows next, and hollows the most expensive. For semi-hollows the minimum gap width which can be formed, even in the soft alloys, is about 0.030″. Whether a shape will be considered as a solid or a semi-hollow depends on the tongue ratio. Figure 6 shows a typical semi-hollow. The tongue ratio is determined as the area of the void divided by the square of the gap width. The tongue ratio for different gap widths is given in Table II. If the ratio is less than that given in the table the part will be classed as a solid. For example, with a gap width of 0.060″ and a ratio of 2.3 the part is a semi-hollow. If, however, the ratio is 1.8, the part is a solid. Since the die costs and the part costs will vary considerably if the part changes from a solid to a semi-hollow, the designer should try to keep parts in the solid shape group.



7. VARIATIONS (B and C) of basic design (A) permit thinner sections and lower costs.

D FACTOR

Another cost time the designer should consider is the D (Difficulty) factor. This is another of the standard factors used to determine the cost of an extruded section. The factor is determined by first calculating a constant, "f", from the formula

$$f = \frac{CP^2}{2A}$$

where:

C is the diameter of the circumscribing circle in inches.
P is the perimeter of the circumscribing circle in inches.
A is the cross section area of the part in square inches.

from "f" and the diameter of the circumscribing circle the D factor is determined from Table III. For example if the circumscribing circle is over 2″ and under 3″ and f is 300 then D is 60. This formula, and Table III, show clearly how the cost of an extrusion increases as the wall thickness, and hence the cross section area, decreases.

Two other factors are considered when pricing an extrusion. These are the weight per foot and the alloy used. Both of these are within the control of design. Naturally, the softer alloys are the least expensive and are the easiest to push. However, required mechanical or physical properties may limit the choice. The harder alloys, 2014, 2024, and 7075 are the most expensive to extrude and should only be specified when the mechanical properties require them. These same alloys weigh more per cubic inch than the soft alloys 6061 and 6063 so that this factor will also make extrusions from them more expensive.

We have, now, developed the three variables the designer must consider when considering an extrusion. The "D" factor, the alloy, and the weight of the extrusion per foot. Within limits, all of these are under the design engineer's control.

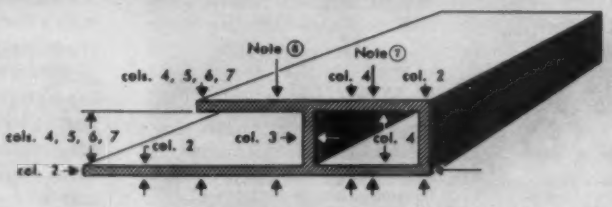
SHAPE VS COST

Now consider the best way to design a shape. Suppose, for example, a simple, rectangular hollow is required as shown in figure 7A. For a part of these dimensions the circumscribing circle is 5″ in diameter. In alloy 6061 the minimum wall thickness is 0.109″ (see Table I). Die costs for this part would be about $600 to $700. It has a low D factor, but the portion of the cost determined by the D factor is much higher for a hollow than for a solid.

One possible redesign of this piece is shown in figure 7B. Here, the circumscribing circle is the same size, but since we are dealing with a solid shape instead of a hollow the die costs will be only $210. Further, because we are now dealing with a solid instead of a hollow it is possible to decrease the wall thickness to 0.063″, thus cutting the weight per foot of the extrusion. This simple change will, then, decrease quite markedly the cost per foot of the extruded shape. Also, the D factor portion of the

TABLE IV—STANDARD TOLERANCES FOR ALUMINUM EXTRUSIONS

Cross-Sectional Dimensions—Except for Shapes in -T3500, -T4510, -T6510 and -T8510 Tempers[8]



SPECIFIED DIMENSION Inches	TOLERANCE②③—Inches Plus and Minus											
	METAL DIMENSIONS				SPACE DIMENSIONS							
	ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION WHERE 75 PER CENT OR MORE OF THE DIMENSION IS METAL				ALLOWABLE DEVIATION FROM SPECIFIED DIMENSION WHERE MORE THAN 25 PER CENT OF THE DIMENSION IS SPACE⑥⑦							
	ALL EXCEPT THOSE COVERED BY COLUMN 3		WALL THICKNESS④ COMPLETELY⑤ ENCLOSING SPACE 0.11 SQ IN. AND OVER (Eccentricity)		AT DIMENSIONED POINTS 0.250-0.624 INCH FROM BASE OF LEG		AT DIMENSIONED POINTS 0.625-1.249 INCHES FROM BASE OF LEG		AT DIMENSIONED POINTS 1.250-2.499 INCHES FROM BASE OF LEG		AT DIMENSIONED POINTS 2.500 INCHES OR MORE FROM BASE OF LEG	
Col. 1	Col. 2		Col. 3		Col. 4		Col. 5		Col. 6		Col. 7	
	Alloys 5083, 5086, 5456	Other Alloys	Alloys 5083, 5086, 5456	Other Alloys	Alloys 5083, 5086, 5456	Other Alloys	Alloys 5083, 5086, 5456	Other Alloys	Alloys 5083, 5086, 5456	Other Alloys	Alloys 5083, 5086, 5456	Other Alloys
Up through 0.124	.009	.006			.015	.010	.018	.012	.021	.014	.024	.016
0.125-0.249	.011	.007			.018	.012	.021	.014	.024	.016	.030	.020
0.250-0.499	.012	.008			.021	.014	.024	.016	.027	.018	.033	.022
0.500-0.749	.014	.009	Plus	Plus	.024	.016	.027	.018	.030	.020	.039	.026
0.750-0.999	.015	.010	and	and	.027	.018	.030	.020	.033	.022	.045	.030
1.000-1.499	.018	.012	minus	minus	.030	.020	.033	.022	.039	.026	.051	.034
1.500-1.999	.024	.016	15%	10%	.036	.024	.042	.028	.051	.034	.075	.050
2.000-3.999	.036	.024	of	of	.048	.032	.054	.036	.072	.048	.096	.064
4.000-5.999	.051	.034	specified	specified	.063	.042	.075	.050	.096	.064	.132	.088
6.000-7.999	.066	.044	dimension;	dimension;	.081	.054	.093	.062	.123	.082	.168	.112
8.000-9.999	.081	.054	±.090 max	±.060 max	.096	.064	.111	.074	.150	.100	.204	.136
10.000-11.999	.096	.064	±.015 min	±.010 min	.111	.074	.132	.088	.174	.116	.240	.160
12.000-13.999	.111	.074			.126	.084	.150	.100	.201	.134	.276	.184
14.000-15.000	.120	.080			.135	.090	.159	.106	.213	.142	.294	.196

①*These Standard Tolerances are applicable to the average shape; wider tolerances may be required for some shapes and closer tolerances may be possible for others.*

②*The tolerances applicable to a dimension composed of two or more component dimensions is the sum of the tolerances of the component dimensions if all of the component dimensions are indicated.*

③*When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the Standard Tolerance is that which would apply to the mean of the maximum and minimum dimensions permissible under the tolerance.*

④*Where dimensions specified are outside and inside, rather than wall thickness itself, the allowable deviation (eccentricity) is ±10% of mean wall thickness; ±0.060 inch maximum, ±0.010 inch minimum. (Mean wall thickness is the average of two wall thickness measurements taken at opposite sides of the void.)*

⑤*In the case of Class I Hollow Shapes the standard wall thickness tolerance for extruded round tube is applicable.*

⑥*At points less than 0.250 inch from base of leg the tolerances in Col. 2 are applicable.*

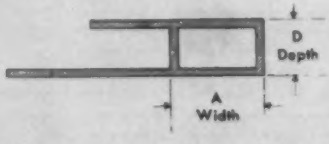
⑦*The following tolerances apply where the space is completely enclosed (hollow shapes):*

For the width (dimension A, below) the tolerance is the value shown in Col. 4 for the depth (dimension D).

For the depth (dimension D, below) the tolerance is the value shown in Col. 4 for the width (dimension A).

In no case is the tolerance for either width or depth less than at the corners (Col. 2, metal dimensions).

⑧*Tolerances for extruded shapes in -T3510, -T4510, -T6510 and -T8510 tempers shall be as agreed upon between purchaser and vendor at the time the contract or order is entered.*



Example—hollow shape having 1 x 3 inch rectangular outside dimensions: The width tolerance is ±0.024 inch and the depth tolerance ±0.032 inch. (Tolerances at corners, Col. 2, metal dimensions, are ±0.024 inch for the width and ±0.012 inch for the depth.)

cost is lower. However, there is now a joining problem, welding, riveting, thread cutting screws, or adhesive bonding. Any one of these will be an added cost in manufacture and may decrease strength or rigidity. In the long run it may be more costly than the hollow.

Finally there is a third design possibility if some joining method is permissible. This design is shown in figure 7C. Here the circumscribing circle is only 3" so that die costs are reduced to $125. Also, because of the smaller circle, the wall thickness can again be reduced to 0.050" if desired. Another advantage of this shape is that it can be made to close enough tolerances so that the two parts will interlock and no fastening problem will exist. This is particularly true if a simple locking device is incorporated in the extrusion. Except, possibly, for a slight increase in weight per foot of section, the cost will not change by including a lock.

TABLE V—STANDARD TOLERANCES FOR ALUMINUM EXTRUSIONS

Straightness, Flatness, Twist, Contours, Radii, Angles, Roughness

Type of Tolerance	Dimension to Which Tolerance Applies (1)	Tolerance
STRAIGHTNESS (2)	Circumscribing Circle Diameter (3): Up through 1.499" Up through 1.499" 1.500" and up	± .0500" per foot (4) for minimum thickness up through .094" ± .0125" per foot for minimum thickness .095" and up ± .0125" per foot
TWIST (2)	Circumscribing Circle Diameter (3): Up through 1.499" 1.500"—2.999" 3.000" and up	± 1° per foot ± ½° per foot; 5° total ± ¼° per foot; 3° total
CONTOUR	Deviation from specified contour	± .005" per inch of chord width (± .005" minimum) (5)
CORNER AND FILLET RADII	Sharp Corners Specified Radius up through .197" Specified Radius .188 and up	+ ¼" ± ¼" ± 10 percent
ANGLES	Minimum Specified Leg Thickness Under 188" .188" to 750" .750 to solid	± 2° ± 1½° ± 1°
FLATNESS		± .004" per inch of width (± .004" minimum)
SURFACE ROUGHNESS (6)	Section Thickness: Up through .063" .064"—.125" .126"—.188" .189"—.250" .251" and up	.0015" maximum depth of defect .002" maximum depth of defect .0025" maximum depth of defect .003" maximum depth of defect .004" maximum depth of defect
SQUARENESS OF SAWCUTS		± 1°
LENGTH	Specified Length up to 10' Specified Length 10' to 30' Specified Length 30' and up	+ ⅛" + ¼" + ½"

NOTES:

(1) These tolerances are applicable to the average shape. Wider tolerances may be required for some shapes, and closer tolerances may be possible for others.

(2) Not applicable to annealed (0 temper) material.

(3) The smallest circle that will completely enclose the shape.

(4) When weight of shape on flat surface minimizes deviation.

(5) Applicable to not more than 90° of any arc.

(6) Includes die marks, handling marks, polishing marks.

(7) Tangent values used in calculation of twist and angularity tolerances:

Tan	30'	.0087	2° 30'	.0437
	1° 0'	.0175	3° 0'	.0524
	1° 30'	.0262	4° 0'	.0699
	2° 0'	.0349	5° 0'	.0875

TOLERANCES

Extrusions can be made to very close tolerances. Like every other metal forming method the piece costs go up as the dimensional tolerances become tighter. Particularly with aluminum and magnesium, machined tolerances can be held if the piece cost will stand a redrawing operation.

It is by far the best to stick closely to the commercial tolerances which have been set up by the aluminum extruders. These are the closest that can be held and still produce sections at a reasonable cost and with minimum scrap. The tolerances for extruded rod, bar, and shapes are given in Table IV.

In addition to the tolerances in Table IV, the aluminum extruders have set standards for straightness, twist, angularity, corner and fillet radii, flatness, surface roughness, and some others. These commercial tolerances are given in Table V.

DIMENSIONING

Most designers believe that they know how to dimension a part drawing. This may be true if standard machine shop operations are involved or if the part is to be a relatively rough casting such as a sand casting.

With extrusions, however, dimensioning becomes more critical. The improper use of reference points and lines can cause repeated arguments as to whether a shape meets specifications or not. For example, the three shapes shown in figure 8 show recommended and not recommended methods of dimensioning. Note that in all cases not recommended some or all of the dimensions refer to a non-existent point or line whose location can vary enough to throw the shape out of tolerance or in tolerance depending upon the inspector. Always dimension so that measurements

are made between definite locations.[1]

JOINTS & JOINING

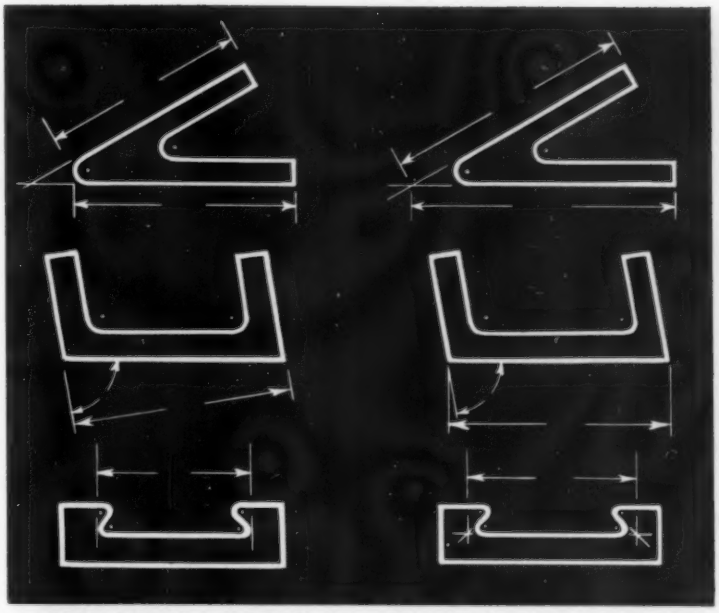
Aluminum extrusions can be joined to each other or to other structures by any of the standard methods such as welding, brazing, riveting, staking, machine screws, self-tapping screws, etc. To use any of these methods may, however, destroy some of the value which can be gotten from an extruded shape. As long as a joining method does not increase the size of the circumscribing circle, it doesn't add to the tooling costs to include joining or locking methods. It's possible, of course, that the inclusion may change the D factor, but this is doubtful. Dovetails, keys and keyways, hinge parts and many other holding and locking devices may be a part of the extrusion so that subsequent machining and assembly are either eliminated entirely or greatly reduced. A few typical examples of extruded joints are shown in figure 9.

Remember too, extruded sections can be bent so that specially fabricated parts and mechanical joining methods can be eliminated.

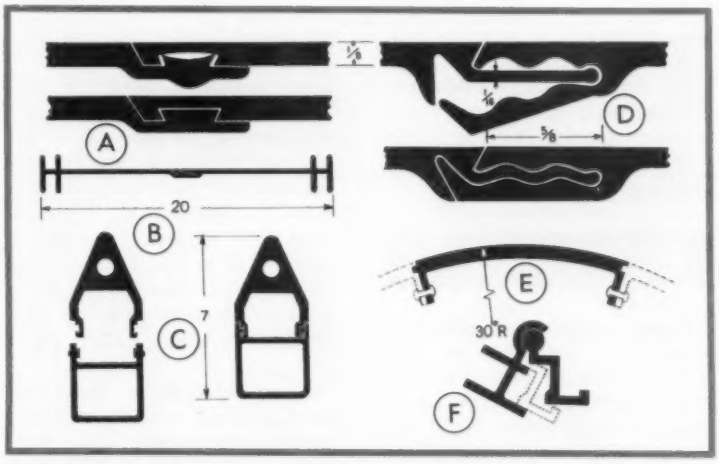
Where maximum joint strength is required it will probably be necessary to weld or braze. Where lower strength in the joint can be tolerated one of the soft solders or the newer adhesives may be adequate.

Where an aluminum extrusion is to be joined to a part fabricated by some other method, it is often possible to form part of the joining device on the extrusion so that only one half of the joint needs to be machined.

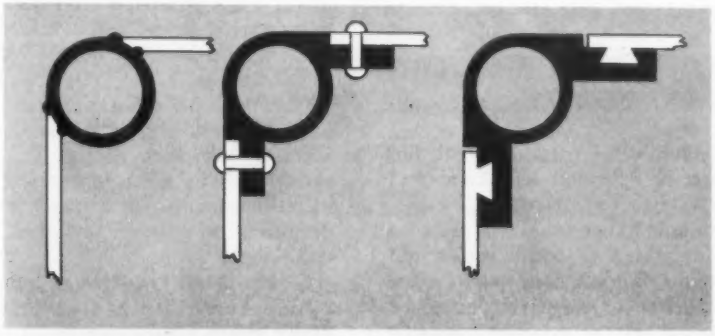
For example, in figure 10 three possible methods of making a joint at a corner post are shown. Frequently this type of structure has the side plates and the



8. **RECOMMENDED and not recommended methods of dimensioning.**

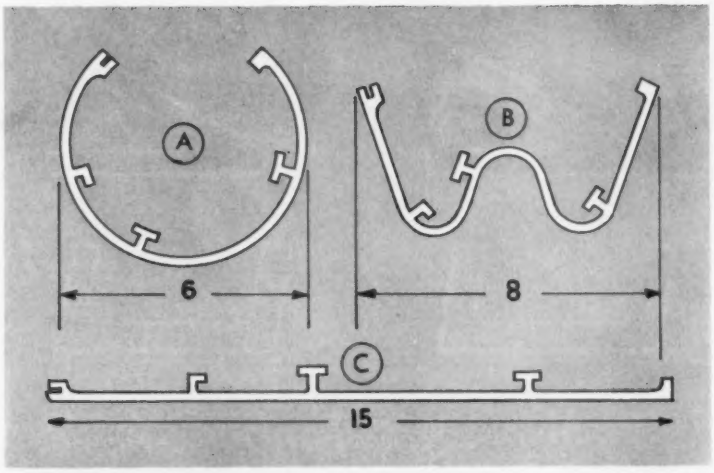


9. **EXAMPLES of extrusion joints. Tongue-and-groove (A) and dovetail (D) fits are secured by rolling passes. Shapes which cannot be produced as integral sections (B and C) can be joined after extrusion. Large diameter cylinder is built from extruded segments (E). Hinge is formed by ball and socket joint (F).**



10. **THREE POSSIBLE METHODS for making a joint at a corner post.**

(1) Drafting Standards for Aluminum Extruded and Tubular Products. Third edition and Supplement. Published by The Aluminum Extruded Products Division of The Aluminum Association, 420 Lexington Ave., New York 17, N.Y.



11. WIDE EXTRUSION can be made from a small circumscribing circle by flattening section after extrusion.

corner post as extruded sections. When this is the case the dovetail locking devices are easily included as a part of the extrusion, usually at no extra cost.

A further advantage of integrally extruded joints is that prefinished parts can be assembled without damage to the finish and with a material saving in finishing costs.

WIDE EXTRUSIONS

Even though most extruders cannot form very wide parts, it is often possible to get a very wide part from a relatively small circumscribing circle. Two examples of this are shown in figure 11. There will probably be some loss of dimensional accuracy when this scheme is used, but if that can be tolerated the cost of wide extrusions can be drastically cut.

FINISHING

While the natural smooth finish of extruded aluminum and the excellent resistance of aluminum to corrosion will often be adequate, a wide variety of other finishes are possible for decorative, wear resistance, or resistance to extreme corrosive conditions.

Mechanical Finishes: Various grades of matte or lustrous surfaces can be produced by polishing, scratch brushing, sand blasting, hand hammering, and combinations of these. When one of these methods is used it is common practice to apply a protective coating of lacquer. Either a clear or tinted lacquer may be used for protection. Such a finish is quite durable if reasonable care is given the article when it is in use. Probably the widest application of this finish is in architectural products such as windows, doors, panels, etc.

Chemical Finishes: Some decorative effects can be obtained by chemical methods which cannot be secured by mechanical methods. A frosted finish, for example, is produced by chemical etching. Where the bright finish of naturally extruded metal is not desired, a mild etch will tone it down without destroying the inherent beauty of the aluminum.

Chemical polishing produces a chromium-like silvery smooth surface, but this Bright Dip should not be used to replace mechanical polishing where it is necessary to remove scratches.

Conversion Coatings: For added corrosion protection where the natural color of aluminum is not required or as a paint base, a chromate conversion coating is used. This finish gives good tooth for an organic finish and provides excellent corrosion protection, but it has little abrasion resistance. It should be used as a final finish only where there is no possibility of wear. It is, of course, used under all organic finishes where the only purpose is to secure good adhesion of the paint.

Anodic Finishes: Electrochemical oxidation of aluminum produces a hard tenacious coating on the surface of the aluminum. When properly applied, such a finish is very resistant to both corrosion and to abrasion.

An anodized surface can be made to simulate chromium plating or it can be colored to give a wide variety of decorative finishes. In general an anodized finish stands up well under normal uses. It may be harmed by strong detergents and by scouring. Where the best paint base is required, as on aircraft parts, an anodic finish is used as a paint base.

Chromium Plating: Contrary to popular belief, aluminum can be plated quite easily. A zincate dip is required to give a surface onto which copper can be deposited. Once the zincate surface has been established, chromium plating can proceed in the usual manner for zinc surfaces. Adhesion of the copper, nickel, chromium is not as good as on zinc die castings, for example, due to the poor bond between the zinc coating and the aluminum. For decorative use this finish is quite adequate.

Organic Finishes: Any organic finish applicable to metals in general can be used on aluminum. The metal surface must be thoroughly cleaned and a primer coat of zinc chromate (a chemical conversion coating) applied. Subsequent paint application and treatment is the same as for any other metal.

(Note: Material for this report was supplied by The Aluminum Co. of American, Kaiser Aluminum & Chemical Sales Co., Reynolds Metals Co., and The Aluminum Association.)

MAGNESIUM ALLOYS CAN BE INVESTMENT CAST

By KENNETH HERRICK, *Project Engineer, and*
HARRY MATTHIESON, *Research Director, Arwood Corporation*

In this second article the authors give information on investment casting magnesium in any "geometry" that can be investment cast in aluminum. The first part appeared in PMM, March 1961, p. 53.

IT IS ALWAYS IMPORTANT TO DESIGN for the process, and specify extremely close tolerances only where they are actually needed.

As a general rule, investment casting can hold tolerances of ±0.005" per inch and produce a low-cost casting. However, if still tighter tolerances are needed, it is possible to hold tolerances of ±0.003" per inch when absolutely needed. But it must be remembered that the tighter the tolerances, the more expensive the casting.

Other considerations must also be taken into account when designing magnesium or any investment casting.

Radii—The general tolerance for radii is ±1/64", but if necessary this can be reduced to a span of 0.005". In general, though, the best rule is to allow as generous a radius as possible, and avoid sharp corners.

Straightness—If finished castings have long, thin sections, they must be mechanically straightened. Table III lists both the as-cast and straightened tolerances which can be expected for varying lengths and thicknesses.

TABLE III

LENGTH	F. I. R.* AS CAST	F. I. R.* FUNCTIONAL
2" long or less	±.010	±.005
2"-4" long	±.015	±.010
4"-6" long	±.020	±.010
over 6" long	±.030	±.015

*full indicator reading

Flatness—Mechanical straightening is also necessary to eliminate bow, twist and waviness in typical flat sections. While the tolerances listed in Table IV are for flat, rectangular castings, they can be applied to any flat piece regardless of its irregular shape.

TABLE IV

LENGTH	AS CAST	FUNCTIONAL
1"	±.008	±.004
2"	±.016	±.006
4"	±.024	±.010
6"	±.030	±.015

Concentricity—The larger the outside diameter, the closer to concentric the inside diameter can be cast. Further, a larger outside diameter makes the part easier to straighten, even though the walls may be heavier. Table V shows the amount of concentricity which can be expected between inner and outer diameters of as-cast parts.

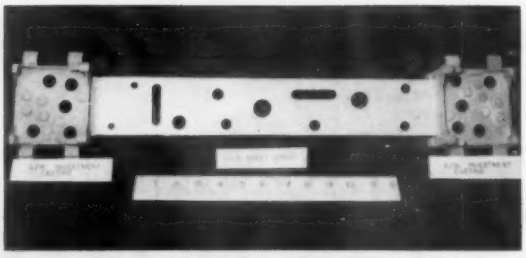
TABLE V

OUTSIDE DIAMETER	INSIDE DIAMETER	F. I. R.* AS CAST	F. I. R.* FUNCTIONAL
¾"	¼"	.004	.004
1"	½"	.005	.005
1½"	¾"	.008	.005
2"	1"	.010	.008

*Full indicator reading

Roundness—The ±.005-inch per inch general linear tolerance also applies for diameters, but this tolerance can be improved on hollow tubular shapes which can be straightened mechanically after casting.

PHOTOMICROGRAPH of magnesium Alloy AZ92-T4 temper showing fine grained investment cast structure, weld fusion and very fine grained weld deposit metal. Weld rod used was AZ92. Welding method was heli-arc.



WELDED ASSEMBLY of two AZ91 castings with AZ31 sheet. The filler rod used for welding was AZ61.

TWO AZ92 CASTINGS are shown separately and as a welded assembly. The filler rod was AZ92.

Angles—As a general rule, a part designed for investment casting should not call for angular tolerances closer than ±½°. But if a closer angle is required, it can sometimes be achieved by mechanical straightening.

Parallel sections—Parts with parallel sections connected at one end can be cast to within ±0.005-inch per inch of parallel. If they are very long sections, mechanical straightening must frequently be used. Table VI shows the actual tolerances which can be achieved.

TABLE VI

DISTANCE BETWEEN SECTIONS	AS CAST	FUNCTIONAL
1/16"	±.003	±.003
⅛"	±.003	±.003
¼"	±.003	±.003
½"	±.005	±.004
¾"	±.006	±.004
1"	±.007	±.005
1½"	±.010	±.007

Holes—Standard dimensional tolerances apply to holes in general. Investment casting is a particularly versatile process as far as holes are concerned, for it is even possible to cast holes with greater diameters inside than at their mouths. Intersecting holes can also be cast.

As stated previously, these general rules apply to all investment castings, not only those in magnesium. But consideration of them in designing parts for investment castings will result in the best casting at the lowest possible price.

Of particular interest to designers planning assemblies of magnesium parts are the established procedures for welding magnesium castings. Several magnesium castings can be joined as a single unit, or a magnesium investment casting can be joined to a magnesium part produced by some other method of production.

Table VII lists the weld rods equivalent to accepted casting designations. Table VIII gives the correct rod for joining any alloys by inert arc welding.

TABLE VII

WELDING ROD TO BE USED FOR MAGNESIUM ALLOY CASTINGS

TRADE DESIGNATION OF CASTING ALLOY	WELD ROD CLASS PER MIL-R-6944A	TRADE DESIGNATION OF WELD ROD
AZ92A	AZ92A	AZ92A
AZ91C	AZ92A	AZ92A
AZ81A	AZ92A	AZ92A
AM100A	AZ92A	AZ92A
EZ33A	EZ33A	EZ33A
HK31A	HK31A	HK31A
AZ31	AZ61A	AZ61A
M1A	M1A	M1A

EDITOR'S NOTE—*In the March 1961 article it was mentioned that the castings were made at the Groton, Conn. plant of Arwood. They were actually made at the Tilton, New Hampshire plant.*

TABLE VIII — RODS FOR INERT ARC WELDING MAGNESIUM ALLOYS

BASE ALLOY → / FILLER ALLOY ↓	A3A	AM100A	AZ31B&C	AZ61A	AZ63A	AZ80A	AZ81A	AZ91C	AZ92A	EK30A	EK41A	EZ33A	HK31A	HM21A	HM31A	HZ32A	K1A	MIA MG1	QE22A	ZE10A	ZE41A	ZH62A	ZK21A	ZK51A	ZK60A&B
A3A	1. AZ92A 2. AZ61A																								
AM100A	1. AZ92A 2. AZ61A																								
AZ31B&C	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A																						
AZ61A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A																					
AZ63A	X	X	X	X	1. AZ63A 2. AZ92A																				
AZ80A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A																			
AZ81A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A																		
AZ91C	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A																	
AZ92A	X		X	X	X	X	X	AZ92A	AZ92A																
EK30A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	EZ33A															
EK41A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	EZ33A	EZ33A														
EZ33A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	EZ33A	EZ33A	EZ33A													
HK31A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	EZ33A	EZ33A	EZ33A	EZ33A												
HM21A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A *HM31A											
HM31A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A *HM31A	EZ33A *HM31A										
HZ32A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A									
K1A	**		**	**	X	**	**	**	X	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A								
MIA MG1	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	X	X	X	X	X	X	EZ33A	EZ33A	EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	EZ33A	1. MIA 2. AZ92A 3. AZ61A 4. EZ33A							
QE22A	X	X	X	X	X	X	X	X	X	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A						
ZE10A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	EZ33A	1. AZ92A 2. AZ51A 3. EZ33A					
ZE41A	X	X	X	X	X	X	X	X	X	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A	EZ33A					
ZH62A	X		①AZ92A ⊕AZ61A	①AZ92A ⊕AZ61A	X	①AZ92A ⊕AZ61A	①AZ92A ⊕AZ61A	①AZ92A ⊕AZ61A	X	○EZ33A	○EZ33A	○EZ33A	○EZ33A	○EZ33A	○EZ33A	○EZ33A	○EZ33A	○EZ33A	X	○EZ33A	① AZ92A ⊕ AZ61A ○ EZ33A	EZ33A	EZ33A			
ZK21A	1. AZ92A 2. AZ61A		1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	1. AZ92A 2. AZ61A	X	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	EZ33A	1. AZ92A 2. AZ61A 3. EZ33A	EZ33A	X	1. AZ92A 2. AZ61A 3. EZ33A		
ZK51A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
ZK60A&B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

ALLOY	CODE COLOR	SIZE—DIA. (Inches)	FORM	LOTS
M1A	Yellow	1/16; 5/32; 1/8; 5/32; 3/16	36" long Rods, Level & Random Wound Coils†	1 Lb. & 5 Lb. Cardboard Tubes, 50 Lb. Cartons, 7 Lb. Coils
AZ61A	Grey	1/16; 5/32; 1/8; 5/32; 3/16	36" long Rods, Level & Random Wound Coils	1 Lb. & 5 Lb. Cardboard Tubes, 50 Lb. Cartons, 7 Lb. Coils
AZ92A	Orange	1/16; 5/32; 1/8; 5/32; 3/16	36" long Rods, Level & Random Wound Coils	1 Lb. & 5 Lb. Cardboard Tubes, 50 Lb. Cartons, 7 Lb. Coils
AZ63A	Green	1/8; 5/32 only	36" long Rods, Level & Random Wound Coils	1 Lb. & 5 Lb. Cardboard Tubes, 50 Lb. Cartons, 7 Lb. Coils
HK31A	Gold	1/16; 1/8; 3/16	36" long Rods, Level & Random Wound Coils	1 Lb. & 5 Lb. Cardboard Tubes, 50 Lb. Cartons, 7 Lb. Coils
EZ33A	Pink	1/16; 1/8; 3/16	36" long Rods, Level & Random Wound Coils	1 Lb. & 5 Lb. Cardboard Tubes, 50 Lb. Cartons, 7 Lb. Coils

NOTE: Other Alloys and Forms Subject of Special Inquiry.

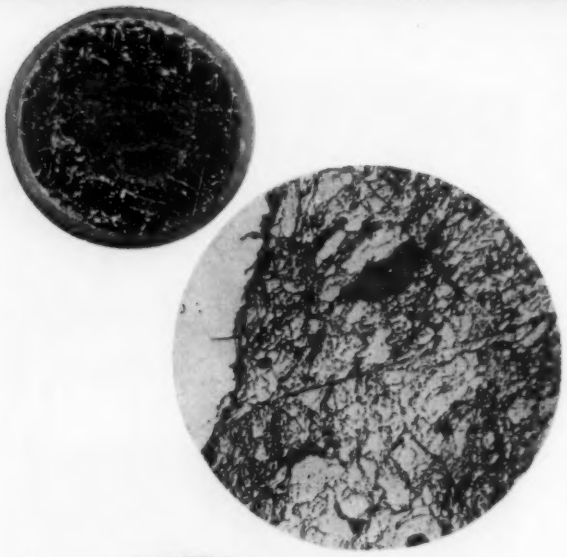
NOTES

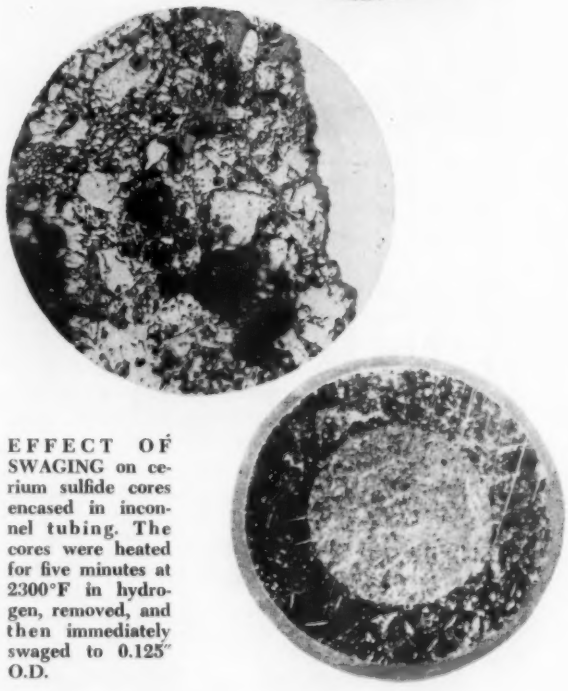
1. X = Welding not recommended.
2. Where more than one filler alloy are listed, they are given in order of preference. The No. 1 alloy was chosen for best weldability or maximum strength, or both.
3. Generally speaking, only two filler alloys would be required for most fabrication shops doing magnesium welding. They are:
   (1) AZ92A for the Aluminum-Zinc series of alloys;
   (2) EZ33A for the Magnesium-Thorium and Magnesium-Rare Earth series of alloys.
4. AZ61A filler alloy is used for welding the Aluminum-Zinc series of alloys when cost is the prime factor.
5. *When welding the Magnesium-Thorium series of alloys, use HM31A filler alloy when resistance to creep above 600°F is the prime factor.
6. In emergency, most alloys may be welded with strips cut from the parent metal.
7. ** = No experience in welding K1A alloy to other alloys shown. AZ92A filler alloy probably satisfactory.
8. ○ = No experience in welding ZH62A alloy to other alloys shown. Rods circled probably satisfactory.

small diameter, long, non-circular holes can be cored in castings with . . .

CERIUM SULFIDE CORES

By H. KIRTCHIK, *Flight Propulsion Laboratory, General Electric Co.*





EFFECT OF SWAGING on cerium sulfide cores encased in inconnel tubing. The cores were heated for five minutes at 2300°F in hydrogen, removed, and then immediately swaged to 0.125" O.D.

LONG, HOLLOW PASSAGES in investment castings have been very difficult and sometimes impossible to get. This sometimes prevented the use of investment castings in some designs.

General Electric Co.'s Flight Propulsion Laboratory Department has developed a cerium sulfide core. It has mechanical strength, resists attack by molten metals, and can be formed into thin cores.

This new core material should enable designers to specify small diameter, long holes in investment castings. General Electric was looking for a way to provide cored holes in air-cooled turbine buckets, but the material need not be limited to this use. Any investment casting, particularly in steel, requiring small holes can now be specified with the holes cored. Tolerances are good, surface finish excellent, and the costs should be moderate. The widest use will be in hard to machine materials, or where the length of the hole is so great that drilling is not feasible.

The properties of cerium sulfide (CeS) which make it desirable as a core material are:

- Complete spalling resistance up to 2500°C (4500°F).
- No failure from thermal shock at heating and cooling rates up to 1000°C (1800°F) per minute.
- Useful for pouring temperatures up to 2000°C (3600° F). This applies mostly to CeS used as a crucible material. It indicates resistance to erosion by molten metals.
- Good high temperature strength.
- Does not decompose in hydrogen, nitrogen, noble gases, or vacuum.
- Does not react with any metal except platinum.
- Soluble in several non-corrosive liquids.
- Surface finish and porosity are easily controlled.
- Low vapor pressure, only 10^{-5}mm. at 1900°C (3450° F).
- Can be swaged and forged.

A disadvantage of the cerium sulfide is its oxygen sensitivity. Traces of oxygen present as the oxysulfide, Ce_2O_2S, seem to strengthen the material, but excess oxygen forms CeO_2 with destruction of the core.

How the cores are made

Naphthalene is an excellent binder for cerium sulfide. The coremaker dissolves naphthalene in

CERIUM SULFIDE CORES, thin as 0.060″ or up to 1″ diameter, are used to form long holes in investment castings.

MANY HOLES are vacuum cast into this air-cooled bucket. Cores are removed with a solution of hydrochloric acid.

ether and mixes in the sulfide. The ether evaporates leaving the naphthalene binder uniformly distributed through the sulfide. Then the cores are pressed and sintered at a high temperature.

The pressure to form the cores depends on the characteristics desired in the finished part. Temperature and time of sintering also influence quality. However, the maximum temperature is 1850°C and for not more than 30 minutes. Higher temperatures and longer times will give rough surfaces and may volatilize the sulfide. The sintering done in a vacuum or protective atmosphere.

The addition of a small amount of cerium oxysulfide increases room temperature strength of thin sections after sintering. A small amount of the polysulfide Ce_3S_4 will impart a much smoother surface to the cores than pure cerium sulfide. The simultaneous presence of the polysulfide and the oxysulfide lowers the melting point of cerium sulfide excessively; they must be used singly.

One way to make the cores is to press the sulfide around either molybdenum or tungsten wire. Molybdenum is prefered. The wire should be about half the diameter of the finished core. Another way is to dip the wire in a slurry, gradually build in the core diameter, and size it by drawing through a die. Another way to make cores is by direct pressing around the wire or by extruding around wire. Cores as small as 0.060″ diameter have been made in this manner with tolerances of +0.000, —0.005.

Another method of manufacture is to fill a metal tube with the sulfide, seal the ends and then reduce the diameter by swaging or forging. Odd shaped cores are readily made in this manner.

The work done so far indicates that cores as small as 0.020″ diameter can be made. Tolerances on these small cores will be at least as good as tolerances on silicious core material.

Core removal from the casting

One of the most desirable features of cerium sulfide cores is the ease of removal from the casting. Nearly all dilute acids will dissolve cerium sulfide and one can be chosen which will not attack the metal.

The core gives off hydrogen and hydrogen sulfide when it dissolves. The gas agitates the fluid enough to keep fresh acid in contact with the core at all times.

Ultrasonic or electrolytic methods may improve core removal methods. Even without these aids, a core 0.060″ diameter and 1″ long can be completely removed in less than one hour. Cerium sulfide does not wet easily, so a wetting agent should be used. When 1:1 hydrochloric acid is used for core solution, 0.5% by volume of no. 213, Rodine is effective at 150°F.

Making castings with CeS cores

These new cores led to some modification of normal burn-out and casting techniques.

If the usual burn-out time and temperature cycles were followed and a hydrogen furnace used to protect the sulfide cores, a black deposit was left in the mold. The method finally evolved a Glascast mold formed around a wax pattern in which the sulfide cores are placed.

The invested pattern is heated in air at 1600°-1850°F for 30 seconds. The mold is then transferred to a furnace at 250°F. This proceedure removes all but a thin film of wax without danger of cracking the investment due to expansion of the wax.

Vapor degreasing in trichloroethylene removes the final traces of wax. The trichloroethylene must be completely free of hydrochloric acid.

The green mold is then placed in the vacuum pouring furnace and a mold heater set around it. After evacuating the furnace, the mold is heated to 1800°-2000°F for 20 minutes. The mold is now fired and ready to receive the molten metal. After the metal is poured and the casting shaken out, the cores can be removed by solution in 1:1 hydrochloric acid.

EDITOR'S NOTE — *Another article on pre-formed cores will appear in the May 1961 issue.*

shorter lead time with . . .

NICKEL CARBONYL MOLD MAKING PROCESS

By HENRY LEFER, *Eastern Editor*

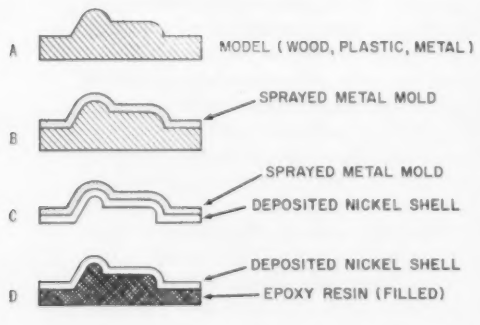
PURE NICKEL PATTERNS, core boxes and permanent molds of great complexity can be made by a new process that eliminates machining and other handwork.

The process, which depends on the decomposition by heat of nickel carbonyl gas to nickel and carbon monoxide, was developed by the Budd Co., Philadelphia, for making forming dies for its own metal stamping business. Further research expanded its application into the foundry. Many additional applications are being studied, including the making of dies for die casting.

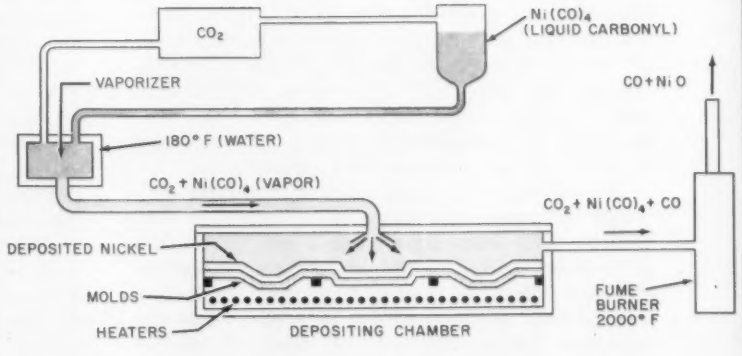
The nickel carbonyl process is not one that most shops can undertake—the gas is extremely poisonous and elaborate safety precautions are necessary—but Budd is offering its die, mold and pattern-making service to the metal-forming and metal-working industry generally. Delivery times are being quoted considerably lower than for previous methods of making these items. Costs are competitive. And both the cost and delivery advantages increase as the complexity of the part increases.

Among the properties of the Budd carbonyl nickel foundry molds are these:

- High abrasion resistance. Brinell hardness is in the range of 181-222. The molds work-harden under the impact of sand from sand slingers, blowers and rammers. Budd says that one die for an automotive manufacturer made over 100,000 impressions without appreciable wear. Examination of the 100,000th stamping indicates that this is true.
- Resistance to heat checking. A thin, rigid shell of pure nickel of uniform thickness is formed, which provides efficient heat conduction and uniform temperature throughout, so no thermal stresses are set up. The pure nickel melts at 2600 F, has a tensile strength of 85,000-95,000 psi, and high ductility (elongation of 15-20 percent). It can be cooled or quenched rapidly, as it has excellent thermal shock properties.



STEPS in making a pure nickel shell from a master pattern using the nickel carbonyl process.

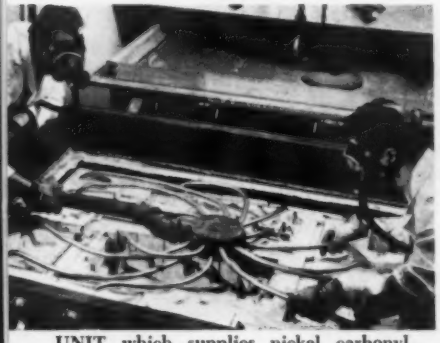


FLOW DIAGRAM shows how CO_2 acts as a "driver", forcing nickel carbonyl into the vaporizer, then into the depositing chamber.

RELEASE AGENT is sprayed on a master engine-head pattern.

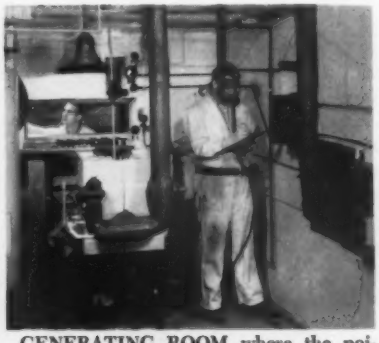
EUTECTIC tin alloy is sprayed on master to form negative.

MOLD (right) is checked against the master pattern.



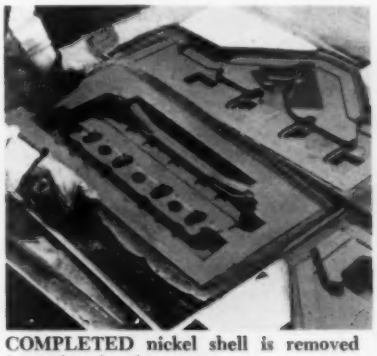
UNIT which supplies nickel carbonyl gas to the deposition chamber.

DEPOSITION chamber with gas spider, thermocouples, and molds in place.



GENERATING ROOM where the poisonous nickel carbonyl gas is produced.

COVER is removed from the deposition chamber after it has been purged.



COMPLETED nickel shell is removed from the chamber.

BACKING OPERATION is sometimes required to strengthen the shell.

• Extremely high dimensional accuracy. The nickel carbonyl process accurately reproduces every detail of the original, regardless of whether the original is wood, plaster, plastic or metal. Surface finish depends on the surface of the original. Reproducibility tolerances are from −.005 in. to +.010 in. overall, with an average tolerance of ±.005 in.

• Easy maintenance. The carbonyl nickel's ductility, toughness and work-hardening characteristics result in patterns and molds of very long life. Repair is comparatively simple, by acetylene or arc-welding, brazing, silver-soldering, or lead-tin soldering.

• Flexibility in size. Patterns can be made from 1 x 1 in. to 60 x 100 in.—actually any size that will fit in the deposition chamber—with no limit on complexity of shape, surface, or shell thickness.

The Nickel Carbonyl Process

Here is how a mold or pattern is made:

1. The customer supplies his own master, in wood, plastic, or metal.

2. The master is inspected, treated with a release agent, then sprayed with a special eutectic alloy of tin until a mold about ½ in. thick is formed. This negative mold is then removed from the master.

3. The tin mold is placed, impression surface up, in the sealed deposition chamber (together with as many other molds as the chamber will hold), and the

chamber's atmosphere is purged and replaced with carbon dioxide. Electric strip heaters across the bottom of the chamber heat the molds to 325-340 F.

4. Nickel carbonyl gas, $Ni(CO)_4$, is introduced through a series of jets connected to a "spider" or manifold. Above 280 F, the gas breaks down into free nickel and carbon monoxide, and since the tin molds are well above this temperature, decomposition takes place. The nickel deposits molecularly on the mold, and the process continues for a few hours or days, depending on the thickness of nickel desired. Coefficient of expansion of the nickel and the mold alloy are identical.

5. The gas flow is stopped and the chamber is purged. The nickel-coated mold is removed and the nickel shell is separated from the tin alloy. The tin mold is destroyed in the process. The shell is now a pure nickel positive reproduction of the master, accurate in every detail. Since it is an exact copy, the master needs take into account only the shrink required to make the end-product castings, and ignores the additional shrink usually required for "cast-to-size" patterns.

The nickel mold may be sent to the customer as a hollow shell, or it may be filled with epoxy resin mixed with iron or aluminum fibers, and a steel backing plate added, with space for lifting bolts or mounting fixtures.

If the customer sends a male mold and wants a female counterpart, or vice versa, an intermediate step is required. An apoxy-plastic negative of the master is made first and this is spray-coated with the eutectic tin alloy. The nickel reproduction then duplicates the epoxy negative rather than the master.

Applications

Budd points out that there is no reason to use the nickel carbonyl process for simple patterns, such as those that can be turned on a lathe. They can be turned cheaper than they can be deposited and are relatively easy to reproduce. But the more milling or Kellering that would be required, the more advantageous the nickel carbonyl process becomes, both from the time and money standpoint. Because the nickel pattern can be delivered in three or four weeks, the time between freezing of design in a new model and first production can be compressed.

At present Budd has one deposition chamber, but a second with three times the capacity is being added at the company's Conshohocken, Pa. facility.

The nickel molds have been used with aluminum, poured at 1400-1500 F, with the mold heated to 500 F. Apparently, a nickel oxide film builds up on the mold at these temperatures, protecting it. Preliminary work indicates that the nickel permanent molds will work well with gray iron castings, as well as for brass and zinc castings. Tin apparently is unsuitable, and no work has been done with magnesium.

Since the nickel shell is relatively thin and no satisfactory method for backing it has yet been worked out, it is not suitable at the moment for die casting dies, although die casting inserts have been made. However, the shell is completely adequate for the relatively light loading of permanent mold casting; it has sufficient tensile strength up to 1400 F for considerable loading, and up to 2200 F for light loading.

Budd is investigating other metal carbonyls, including chromium, tungsten and iron, which promise to offer desirable properties.

TYPICAL PATTERN shows sharp detail and reproducibility.

CARBONYL NICKEL PATTERNS and molds for various automotive applications.

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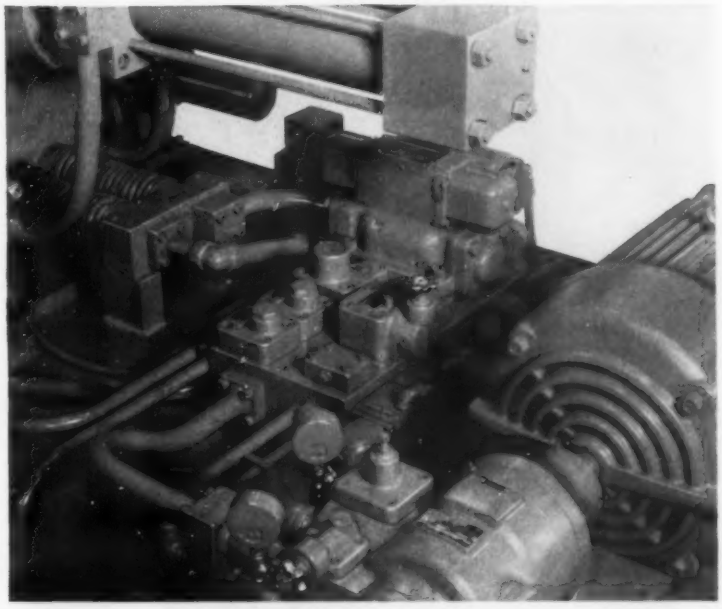

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DESIGN FOR THE PMM PROCESSES

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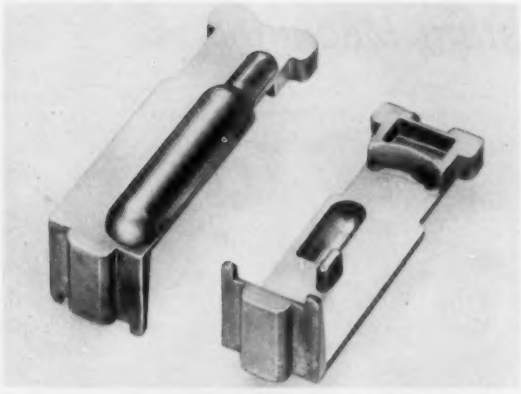


DIE CASTING FOR MORE FIRE POWER

THIS MODERN RIFLE is designed for lightweight and high fire power. It will enable the user to go into combat with 60% more ammunition.

To give the rifle its fast constant fire power, a die cast cam follower pushes ammunition from a 20-round magazine into firing position. To keep with lightweight requirements, it is made of aluminum. Because of fast constant follow through, the aluminum surface is hardened to limit wear and prevent scorching. The Newton-New Haven Co. produces the die casting to exacting tolerances to provide jam-free service.

A relief profile cast in the cam, positions two cartridges simultaneously, and makes it impossible to load ammunition the wrong way.

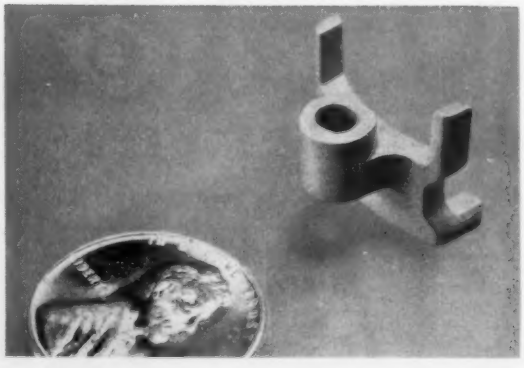
The rifle is made by Colt's Patent Fire Arms Mfg. Co. and is identified as the Colt AR-15 (Armalite). Fire power is 720 rounds per minute with full and semiautomatic fire control. It is also a grenade launcher.

PENNY-SIZED INVESTMENT CASTINGS

CHOOSE SMALL INVESTMENT CASTINGS instead of machined parts. Generally they cost less in quantity production. This is true of the penny-sized part (illustrated) which must also meet rigid safety specifications.

The casting is a switch component used to control an airplane propeller's pitch. For maximum wear-resistance, and therefore for safety, it is investment cast in SAE 8620 steel and case hardened.

Because it is subjected to very high centrifugal force and fatigue when it rotates in the propeller, every part must be X-ray inspected. Casting Engineers, Inc. cast it with many dimensions held to ± .003" tolerance.



Why the DIE CASTER talks D-M-E STANDARD UNIT DIES to the Die Designer and Die Maker

Changeover time goes down ...Profits on short runs go up!

Die changes on zinc or aluminum castings which normally take 3 to 5 hours are now done in minutes with D-M-E Standard Unit Dies.

D-M-E Replacement Units are fully interchangeable: Quickly and easily they're taken out and replaced in the Unit Holder . . . production is continued immediately!

Because several jobs can run on one machine, you increase profits on short run jobs. What's more, you get the quality, the performance and the standardization of replacement parts needed for volume production work.

DIE CASTERS, DESIGNERS AND DIE MAKERS GET MORE FROM D-M-E!

• AVAILABILITY: D-M-E Replacement Units are carried in stock at your local D-M-E Branch for quick delivery. • VARIETY: D-M-E Replacement Units are available in your choice of steel and hardness. • UTILITY: D-M-E has a Standard Unit Die to fit your machine, whether you require rack and pinion or automatic "bumper-type" ejection. • FLEXIBILITY: Complete freedom on three sides of the cavity for core or cooling line placement; six leader pins and bushings for accurate alignment; "quick change" wedge clamps for positive plate positioning. • Start increasing profits on your short-run jobs with D-M-E Standard Unit Dies!

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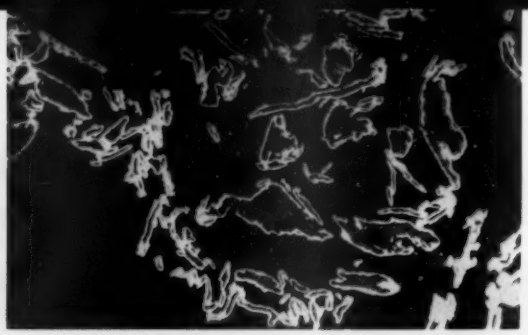
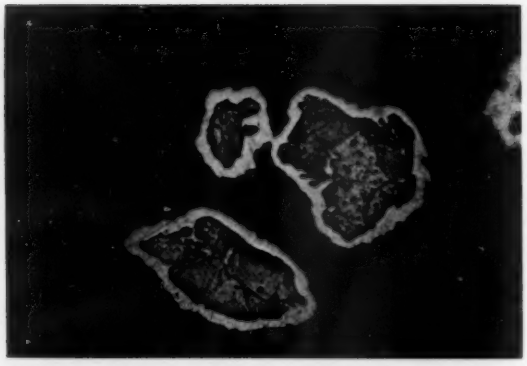


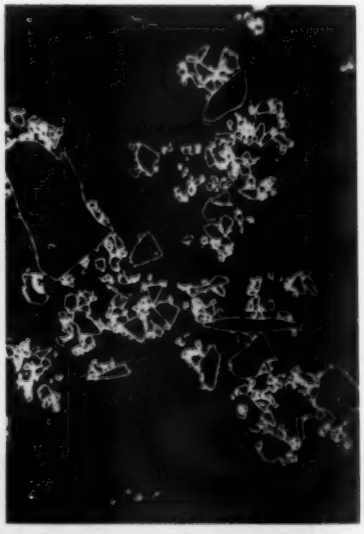
NICKEL ON GRAPHITE FLAKE: 85% by weight nickel. Magnification, 450 times.

COMPOSITE POWDERS

. . . . a new dimension in powder metallurgy



NICKEL ON IRON POWDER: 50% iron by weight. Magnification, 320 times.



NICKEL ON POWDERED GLASS: 75% by weight nickel. Magnification, 320 times.

COMPOSITE POWDERS can be used in powder metallurgy operations where:

- Conventional alloy powders are not available.
- The segregation of components of mixtures is a problem.

These difficulties, most acute where differences in particle size or density between the mixture components are greatest, are easily overcome by combining the two in uniform composite powders.

In a proprietary process developed by Sherritt Gordon Mines Ltd., nickel in purified solution is precipitated by pressurized hydrogen on to the surface of nickel powder particles held in suspension by agitation. Using special catalysts, they are able to specify conditions under which the nickel will deposit on the surface of foreign metal or non-metal particles. Nickel and cobalt have been coated on to the surface of a large number of such core materials.

Powder characteristics

The coating adheres firmly and, if enough nickel or cobalt is provided, a complete impervious layer is obtained. This layer may be only a few microns thick. The quantity of nickel needed depends upon particle size of the core powder and its specific gravity. Particles of less than 1 micron diameter and granules up to ¼" diameter have been successfully coated by the process.

A wide variety of materials have been coated with nickel and cobalt. The refractory carbides, silicides, nitrides, borides and oxides respond satisfactorily. Tungsten carbide, chromium carbide, titanium carbide, silicon carbide, nickel boride, molybdenum disilicide, silicon nitride and other materials of similar characteristics have all been coated. A number of oxides, including aluminum oxide, chromium oxide,

zirconium oxide and silicon dioxide, have also been coated.

Metal powders such as iron, aluminum copper, chromium, tungsten, and molybdenum have been coated satisfactorily. Unusual combinations, including coatings on glass, graphite and diamond, have also been prepared.

The physical and chemical characteristics of the composite powder are dependent upon the nature of the core powder that is coated, as well as upon the coating material. The coating metal is of the same purity as the refined metals that are the major portion of Sherritt's output at present.

Applications

The anticipated applications for these composite powders are many. One immediate use lies in the cemented carbides and cermets industries. Here, a layer of the bonding metal has to be applied to the surface of the carbide or oxide strengthening constituent prior to compacting. Since nickel and cobalt are widely used as the bonding metal, composite powders with tungsten carbide and alumina particles as well as more exotic combinations involving boride, diamond and other materials have been prepared and evaluated in development quantities by a number of concerns.

Nickel can be coated on graphite or glass as well as aluminum and titanium. Applications can be foreseen in conventional powder metallurgy techniques as well as the roll-compacting of composite powders to produce strip in a way similar to that used for pure metals.

The coat of relatively inert nickel or cobalt protects reactive metals from atmospheric contamination. Thus metals like chromium, titanium, molybdenum and other readily oxidized metals can be protected from oxidation by a nickel or cobalt layer.

All three of these characteristics of composite powder; avoidance of segregation, protection from reaction with the atmosphere, and intimacy of contact between the various components, are likely to be of advantage in the preparation of materials for welding electrodes or flame-spraying.

Uncommon shapes possible

Since the coating follows faithfully the contours of the core particle surface, composite particles of shapes not commonly encountered in conventional powder metallurgy can be obtained. Spherical or angular "nickel" particles can be obtained by coating suitable glass or ceramic powders. Porous plates, metallic filters and a number of similar products can thus be prepared economically and with good reproducibility.

Research quantities of these powders for preliminary evaluation studies as well as lots of several tons for semi-commercial testing are available. The production of the composite powders is well advanced and main emphasis is now being placed on the development of uses for these materials in co-operation with interested consumers.

For a more complete metallurgical report on composite powders, see PMM, Oct. '60, page 56; and Nov. '60, page 56.

FOR DIE CAST COMPONENTS

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A good way to improve your product's appearance — lower its cost — give impetus to its sales potential — is to start with your preliminary drawings.

Particularly with zinc and aluminum die cast components, early planning solves many a design and production problem with happy advantages both to manufacturing economy and market appeal.

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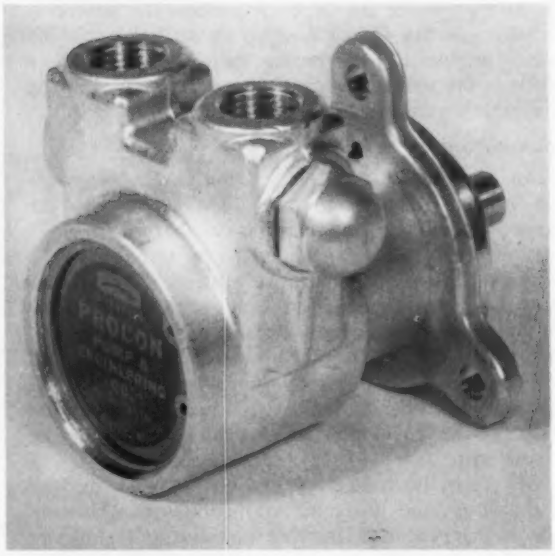
CARBON-GRAPHITE

By V. E. SWANSON, *Procon Pump & Engineering Co.*



1. SELF-PRIMING, rotary vane type, positive-displacement pump operates at close to 100% efficiency, and has a long, maintenance-free life.

ENGINEERING AND DESIGN IMPROVEMENTS are constantly being made on rotary vane type, positive-displacement pumps made by Procon Pump & Engineering Co. However, one factor that resists any change is the number of important pump components made from carbon-graphite. In the most recent major change in the design of the pump, another part . . . the housing liner, against which the vanes rotate . . . was changed to this material.

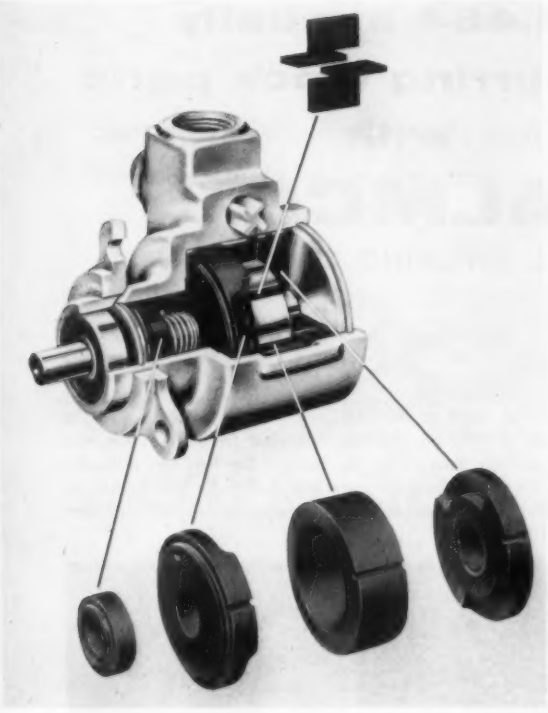
This pump (figure 1) was developed for use in coin-operated, soft-drink vending machines. They are now used to handle many types of liquids . . . water, beverages, detergents, aqueous ammonia, cleaning fluids, refrigerants, fuel oil, gasoline, hydraulic oil, etc. . . . at various temperatures. Many of the original pumps, built in 1949, are still in operation.

Reasons for the success are; the unique design of the pumps, and the selection of materials that provide low starting torque, the absence of metal-to-metal contact, and silent, non-pulsating operation.

Each pump is made to order for a specific application from two standard units—one having a capacity up to 100 gallons per hour, and a larger unit with capacities from 125 to 250 gallons per hour. All pumps operate at pressures up to 200 pounds per square inch, with the required pressure pre-set at the factory. They can be provided with or without a built-in relief valve, and arranged for clockwise or counter-clockwise rotation.

The pumps consist essentially of a housing having inlet and outlet ports, a liner, a rotor having axial slots for the four vanes, end-plate bearings, and seals. For most applications, the housings are made from brass forgings, but in certain instances, such as for pumping aqueous ammonia, the housing is aluminum. Stainless steel housings are used for corrosive fluids.

PARTS IMPROVE PUMP DESIGN



3. TEST-STAND set-up for operating pumps before they are delivered. Coded records are maintained for each pump.

2. CUTAWAY VIEW of pump shows Graphitar seal, end-plate, linear, and vanes.

All of the other major components—the liner, the four vanes, the end-plate bearings, and the seal, as shown in figure 2, are made from Graphitar a carbon-graphite material made by The United States Graphite Company. This versatile, nonmetallic material is produced from graphite powders and a carbon binder that are compacted under high pressures and sintered at temperatures up to 4500°F. Various grades contain from 95% to 99.8% carbon.

Carbon-graphite was selected for these critical pump components because of its wear-resistant properties and long life, a result of its self-lubricating feature. The extremely fine, controlled porosity of the material permits even the lightest liquids to serve as lubricants; they maintain a liquid film at the bearing surfaces under relatively high loads, and reduce the coefficient of friction.

The coefficient of friction (0.04 to 0.25 when operated dry, and even less when used with a fluid) is lower than any other material. Various grades have different porosities, and will absorb up to 13% by volume of any fluid. The material has a low modulus of elasticity, so that it conforms under the pressures of the seals. Another important advantage in this multi-application pump is that it is compatible with most fluids and inert to practically all chemicals. Only highly oxidizing reagents in hot and concentrated forms can react to affect this material.

Since the original unit was built in 1949, all Procon pumps, regardless of their application, have had carbon-graphite vanes, end-plate bearings, and seals. However, the housing liners, against which the vanes rotate, were originally made of Monel. A testing program showed that the wear-resistance of the liner could be doubled by changing to carbon-graphite. In addition to obtaining twice the life, costs have been cut, since Monel was higher priced and more costly to machine.

The vanes, end-plate bearings, and liners are made from two different grades. All diameters of the components, as well as squareness, parallelism, concentricity, and the length and thickness of the vanes, are maintained within a tolerance of 0.0005". Parallelism of the end-plate bearings is held even closer by lapping. Selective assembly of the vanes in the rotor slots results in less than 0.0005" clearance. With this clearance and the proper run-in, a perfect fit is obtained. Since there is no incipient melting at the surfaces there is no galling.

All pumps are tested in actual operation (figure 3) before delivery. Some test pumps have been operated 8000 hours with ordinary tap water. The only limitation is the presence of dirt, abrasives, and foreign material. A strainer on inlet line to the pumps will generally eliminate such objectional material.

REPORT FROM WESTCLOX • *Division of General Time Corporation*

"Here's how we save $46,464 annually by deburring clock parts with ALMCO BARREL FINISHING EQUIPMENT."

"MY NAME IS A. R. BIERBRODT. Here at La Salle, Illinois, I'm Supt. of Metal Finishing for the Westclox Division of General Time Corporation, makers of the famous Big Ben alarm clocks. I'd like to show you how we save big money by using ALMCO barrel finishing machines for deburring and finishing 24 different clock parts in our plant."

(1) "Here, John Chambers lifts the hood of one of our 10 ALMCO machines. We figure we save $46,464 annually by deburring and finishing clock parts with ALMCO barrel finishing equipment."

(2) "Parts to be finished are added to predetermined proportions of media and compounds. A total of 10,000 cast gear wheels, for example, can be deburred and finished in one hour's time."

(3) "Lock 'er up and we're ready to go. Previously, when these clock parts were deburred and finished with power tools, only 3,500 parts were finished during an 8-hour work period."

(4) "A flip of the switch and the precision process begins. Burrs are removed, rough edges smoothed to specifications, and 80,000 perfectly finished parts delivered to production lines each day."

(5) "Here, Harry House, Foreman, inspects clock parts finished by ALMCO Supersheen equipment and methods. Barrel finishing has given us a daily labor saving of $193. What's more, quality and uniformity are good and production is way up. Results are truly outstanding."

LEARN HOW MODERN BARREL FINISHING can improve your product! The facilities of ALMCO's new technician-staffed lab in Albert Lea, Minnesota, are available to you without obligation. Send your sample parts with specifications desired or write on your company letterhead requesting an ALMCO engineer to visit your plant.

SEND FOR YOUR FREE barrel finishing handbook. 52 pages of case history facts and barrel finishing processes. Illustrated equipment section. Includes detailed cost chart on finishing of typical parts. Send for your free copy today!

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copper-nickel-chromium plating is as durable on zinc as on other metals

THICK CHROMIUM PLATING FOR BETTER CORROSION RESISTANCE

THICKER CHROMIUM PLATE may answer the demand for more durable chromium plated zinc die castings. Thick chromium deposits always crack when applied by conventional plating methods. This is just as bad as a too-thin, porous plate. Now, work conducted by the British Non-Ferrous Metals Research Association shows how to control the plating process to get thicker, crack-free chromium deposits.

Copper-nickel-chromium plating is as durable on zinc as it is on other metals. Chromium plate has outstanding corrosion resistance if it is free from cracks and pores. Unfortunately, normal bright chromium plates in a highly stressed state. The stresses increase with plating thickness until the plate cracks when it is more than about 0.00002" thick.

This, then, is the problem: thick coatings crack, thin coatings are porous. In either case the underlying nickel isn't protected well. This problem is acute on complex castings because current density variations cause wide differences in the plating depth.

It is possible to get unstressed deposits 0.0004" thick with a special selenic acid bath. These deposits are free from cracks and have not broken down after years of exposure to an industrial atmosphere. Unfortunately, the selenic acid bath is not good for commercial production because of its poor throwing power and because the resulting plating has a matte finish which requires polishing.

Bath control permits thicker plate

A commercially practical, two-step control of the plating bath permits thicker crack-free chromium plating. These controls are:

- Raise the operating temperature and increase the current density. Brightness and plating efficiency is lost unless the current density is increased in step with the temperature.
- Increase the ratio of chromic acid to sulphuric acid from the normal 100:1 to about 150:1.

These conclusions were drawn after only a limited range of bath compositions were tried, but the results suggest that the chromic acid concentration is not critical if current density and temperature are adjusted correctly.

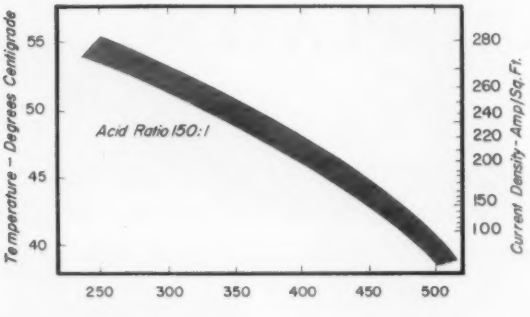
Research at the Battelle Memorial Institute shows that the porosity of the chromium deposit may vary with bath composition, and that there may be an optimum chromic acid concentration for maximum

corrosion resistance. This theory is currently under test.

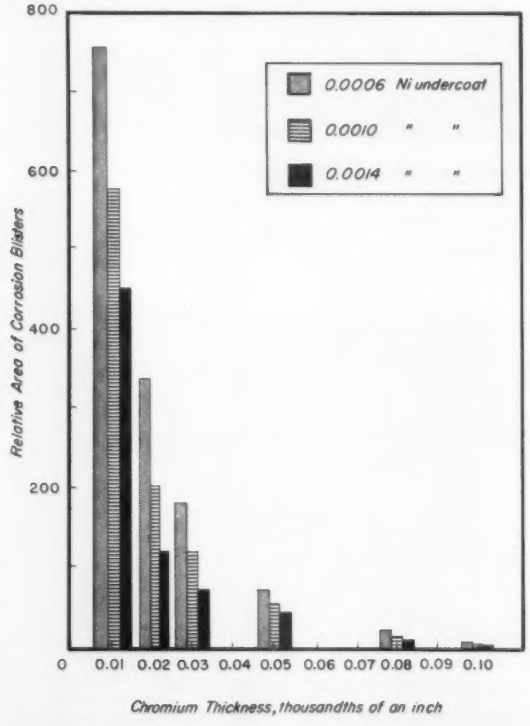
Test results

A test conducted by the British group shows how the amount of corrosion is related to the thickness of nickel and chromium plating. The results of this test are shown in figure 1. In this test two shapes were used: one a typical automobile door handle, the other a flat plate with bevelled edges. The specimens were exposed to an industrial atmosphere for six months.

The plated surfaces were rated on the relative area of corrosion blisters that each developed. This method of rating works well up to a chromium thickness of 0.00005". The appearance of the surface is directly related to the area of corrosion blisters up to that thickness. Over 0.00005", cracking is more pronounced, making the area of blistering less of an indication of appearance.



1. INCREASE in the thickness of chromium and nickel plating lowers the area of corrosion blisters.



2. THICKNESS of chromium over the surface of specimens used in the corrosion tests.

The most important thing the tests show is that increasing the crack-free chromium coating to 0.00002" or 0.00003" produces a great improvement in corrosion resistance.

A copper undercoat of 0.0003" was used in this test. Another test duplicated the above conditions, except that a direct nickel undercoat was used instead of the copper. The results of the two tests were similar. But they indicated there might be an advantage in eliminating the copper because brown products of copper corrosion show through when the plating is penetrated.

Variations in current density cause the chromium to plate to different thickness. This variation of thickness for the parts used in the tests is shown in figure 2. On castings with sharp edges it may be difficult to deposit adequate chromium on flat surfaces without causing cracking on the edges because of excessive build-up.

The tests show that good corrosion resistance depends on an adequate nickel undercoat even when the chromium coating is thicker. The nickel coating should always be at least 0.001". In fact, it may be possible that the duplex nickel technique (applying bright nickel over a dull or semi-bright deposit) may be a better approach to the corrosion problem. This approach is under study.

Probably any point along the curve will give satisfactory results, but three sets of conditions were investigated in more detail. These are shown in Table 1. Remember that these conditions may not be optimum.

The first set of conditions in Table I requires a large increase in current density over that usually used. Its advantage is that thicker chromium deposits can be made without an increase in plating time. The castings in the corrosion test (figure 1) were plated under these conditions.

The second set is conventional plating practice except that the plating time is longer. There are commercial solutions in regular use similar to the one used here. These solutions would probably produce thicker crack-free chromium if the plating time were longer and the temperature increased about 5°F.

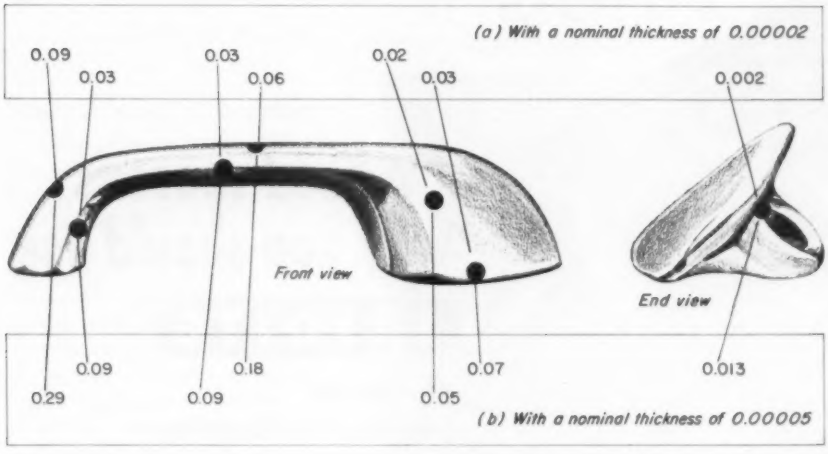
The third set is a compromise between 1 and 2. The goal with this third set was to get the desired thickness of chromium with less temperature and current density increase than with the 250 g/1 bath.

In all cases an increase in the ratio of chromic acid to sulphuric acid ratio is necessary. It's best to try a ratio of 150:1 to start. Acid ratios greater than this tend to reduce the covering power and cause brown stains in recessed areas.

Trivalent chromium is an important element of the solution composition. At least 0.5 g/1 should be used. In the corrosion test described above, 2 g/1 were used.

The best results in the tests were obtained by

TYPICAL DISTRIBUTION OF CHROMIUM THICKNESS ON CAR DOOR HANDLES, IN THOUSANDTHS OF AN INCH



3. OPTIMUM temperatures and current densities for crack-free plating.

starting to plate with 3 volts for the first ¼ to ½ minute after immersion. This is a starting value of between 10% to 50% of the final value. These starting values are helpful in giving maximum covering in low current density areas while reducing the chances of burning at high density points. It is best to determine the best starting current for each part by experiment.

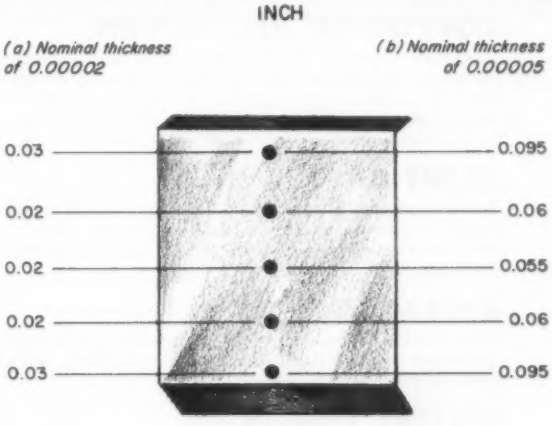
Control tests

The time-of-gassing test, usually used for routine measuring of chromium thickness, has an accuracy no better than ±30%. It's best to have a more accurate test while standardising the plating procedure for each part.

A sufficiently accurate method is to record the quantity of electricity required to strip the chromium electrolytically from a small part of the surface. The weight of coating removed can then be calculated from Faraday's law. Knowing the area which was stripped, the thickness of the coating can be found. The main error with this method is measuring the area stripped. This error can be kept within 5%. You can buy commercial testers that work on this principle.

In general, any tendency for the chromium to crack is uncovered after 24 hours exposure in a sulphur dioxide cabinet.

TYPICAL DISTRIBUTION OF CHROMIUM THICKNESS ON CAST BEVELLED PLATES, IN THOUSANDTHS OF AN INCH



Practical guide

Figure 3 shows how to vary the temperature, current density, and bath composition to get thicker chromium plating. This graph tries to provide:

- The best combination of chromium thickness with freedom from cracks in high current density areas.
- Good throwing and covering power in low current density areas.
- No loss of surface luster.

TABLE I

PROPER PLATING TIME FOR THREE POINTS ALONG CURVE SHOWN IN FIGURE 1.

Condition	Chromic Acid Concentration	Temperature		Average Current Density	Plating Time
	(g/l)	F.	C.	(asf)	(minutes)
1	250	126	52	260—280	4— 8
2	500	104	40	95	10—20
3	375	120	49	230	5—10

LOOK FOR THE DIAMONDS—SIGN OF FINISHING QUALITY

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The wide range of Iridite coatings available gives you a choice of corrosion protection—from economical, mild protection of parts for shipment, storage or display, to extremely high protection under exposure to marine and highly humid atmospheres, gasoline or other hydrocarbons.

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Your choice of colors ranging from clear through yellow iridescent to olive drab. Bright Iridite finishes can also be dyed to provide other color effects.

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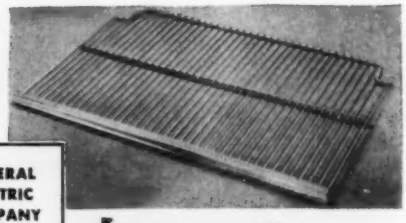
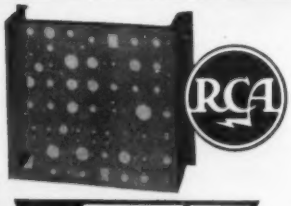
Iridite, in combination with other Allied Research processes, can provide a wide variety of finishes. As an example, Iridite 8-P applied to zinc or cadmium, followed by an application of Irilac, gives a highly attractive simulated brass finish.



GENERAL ELECTRIC COMPANY



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IRIDITE—a specialized line of chromate conversion coatings for nonferrous metals. Easily applied at room temperatures with short immersion times, manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. Special equipment, exhaust systems or highly trained personnel not required.

For complete information on Iridite, contact your Allied Field Engineer. He's listed in the yellow pages under "Plating Supplies." Or, write for FREE TECHNICAL DATA FILES.

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Circle No. 91 on Reader Service Card

new products & developments

Continued from page 20

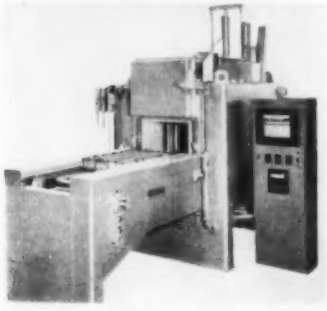
Weight control balances

METTLER INSTRUMENT CORP.—Two automatic weight control balances for powdered metal parts production have been announced by Mettler. One is an automatic filling balance with capacities up to 100 g. and speeds up to 15 loads per minute into die cavities. The second is an automatic check-weighing balance and parts handling system with capacities to 1000 g. and handles 60 pieces per minute.

Circle No. **241** on Reader Service Card

Heat treating unit

HEVI-DUTY ELECTRIC CO.—Clean-Line is a fully automatic heat treating unit constructed



so that it includes all new design improvements that help to speed up production and reduce maintenance costs, the company said.

Circle No. **242** on Reader Service Card

Permanent brightner

CONVERSION CHEMICAL CORP.—Kenvert No. 15-BR, a new concentrated, permanent type brightener for cyanide zinc plating solutions, is soluble in water and the plating solution. The company reports it has excellent stability to break down in zinc solutions operated at higher than normal temperatures.

Circle No. **243** on Reader Service Card

more New Products on next page

For a single tank cleaner to do many jobs

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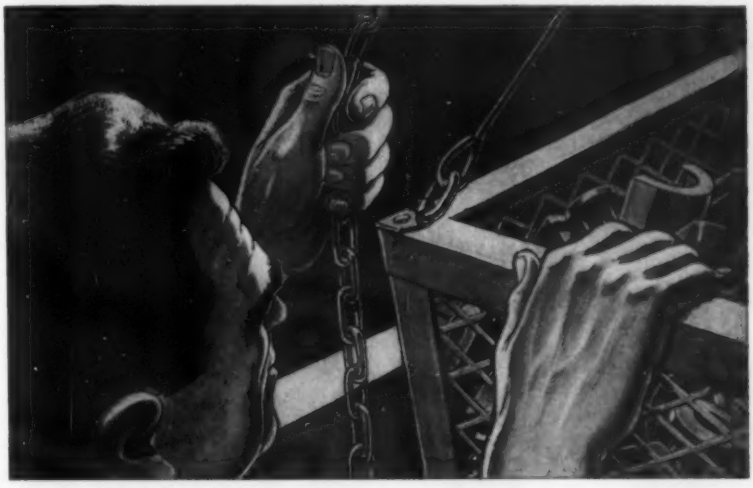
OVER 50 YEARS CLEANING EXPERIENCE • OVER 250 SERVICE MEN • OVER 160 MATERIALS



"RUSTRIPPER" gives you the "universal" tank cleaner . . . removes rust, scale, paint, soils

Here is a remarkable alkaline material with powerful cleaning and chelating action. It conquers a wide variety of soils. In a tank of Oakite RUSTRIPPER, you can remove scale and rust with complete safety. It strips tough paints and phosphate undercoatings with ease. It cleans off metallic smuts, light shop soils, discolorations.

Look at its performance in shop service: "Aircraft parts freed of scale with boiling soak, instead of sand blasting" . . . "oil, welding flux, rust removed in job plating" . . . "soaked steel wrenches give brighter plate" . . . "removes all rust, scale, carbonized oil from diesel liners prior to plating" . . . "displays amazing solution life even though worked very hard" . . . "eliminates pickling and precleaning for barrel-plated screws" . . . "does to bolts in 3 minutes what took pickling 40 minutes". *And that's just a sample.*

Write for Bulletin 9651. Better yet, ask the Oakite man. Oakite Products, Inc., 28A Rector Street, New York 6, N. Y.

it PAYS to ask Oakite

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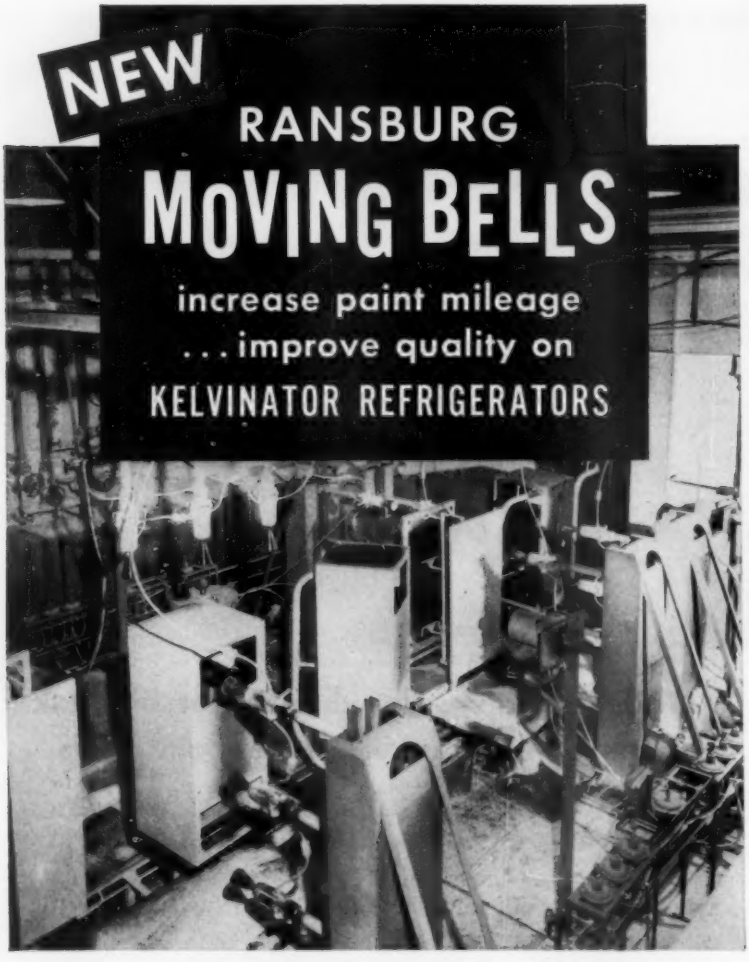


Ransburg's No. 2 Process moving bells—latest innovation in electrostatic painting—automatically paint mixed sizes of refrigerator cabinets and doors on Kelvinator's new finishing line.

On this job—first of its kind—limit switches re-position the reciprocating bells to accommodate various model sizes mixed on the same line. And, electric eyes selectively trigger the paint on and off between parts.

RESULTS? Automatic electrostatic spray painting—which replaced a battery of reciprocating automatic air guns—is providing Kelvinator with a beautiful, higher quality, and more uniform finish. Rejects, formerly a troublesome problem, have been practically eliminated. And, along with appreciable labor savings in this highly automated set-up, paint mileage is substantially improved . . . even bettering the savings indicated in pre-installation lab tests at Ransburg.

Like Kelvinator, other manufacturers of quality products will find Ransburg's moving bells the automation answer for production lines where batching of similar parts is impractical.

NO REASON WHY YOU CAN'T DO IT, TOO!

Want to know how Ransburg No. 2 Process can improve the quality of YOUR painted products—and at the same time—cut YOUR paint and labor costs? Write for our No. 2 Process brochure. Or, if your production doesn't justify automatic painting, let us tell you about the No. 2 Process Electrostatic Hand Gun which can be used in either conveyorized, or non-conveyorized painting.

RANSBURG

RANSBURG Electro-Coating Corp.

Box 23122, Indianapolis 23, Indiana

Circle No. **99** on Reader Service Card

new products & developments

Continued

De-smutting compound

THE DIVERSEY CORP.—Diversey No. 596 will prepare aluminum for conversion coating etching, or for bright dipping or anodizing, the company said. It is a new de-smutting compound claimed to be particularly effective on alloy 6061.

Circle No. **244** on Reader Service Card

Caliper attachment

BRANSON INSTRUMENTS, INC.—A caliper attachment makes it possible to use a Sonoray ultrasonic flaw detector to measure

thickness from one side to ±0.010". The caliper consists essentially of a fixed, scribed, vertical line and a second line on a slider, movable across the face of the cathode tube.

Circle No. **245** on Reader Service Card

New power system

DESPATCH OVEN CO.—Thyratron electronic tubes replace conventional contactors or saturable reactors in the Thermionik Power System method of controlling power to electric heaters for furnaces and ovens, reported the company. Advantages claimed are; lower first cost, greater control, easier servicing, and savings in weight and space.

Circle No. **246** on Reader Service Card

more New Products on page 66

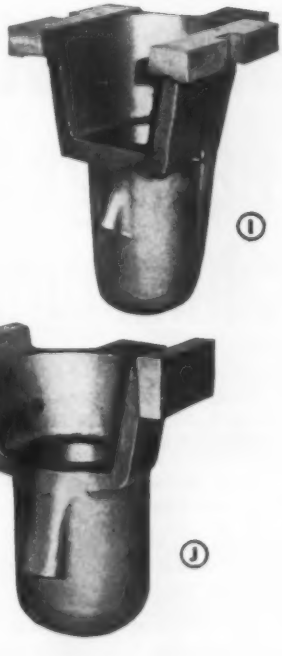
We make them all!

Now, *from stock*, you can obtain longer-lasting *steel* goosenecks* in nominal sleeve sizes for your die casting machines. Dodge goosenecks are machined and sleeved, ready for your use.

Shown here are just a few of the hundreds of Dodge *cast steel goosenecks* we have supplied to industry.

Select the one that fits your machine—then ask us for an eye-opening quotation! If your gooseneck isn't pictured here, ask. Chances are we've made it and it's available. Cast steel replacement parts, from pots to skimmers, are in stock, too.

Write us *today*. We'll be happy to furnish complete details, without obligation.



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Circle No. 25 on Reader Service Card

new products & developments

Continued

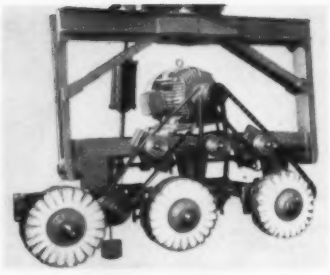
Electrical-discharge machining

EASCO PRODUCTS, INC.—Die-Matic will cut die blocks measuring 3′x4′ and weighing up to 6,000 pounds, announced Easco. It is an electrical-discharge machine that stands seven feet high and weighs 3,500 lb. Ratio of metal-to electrode wear in the roughening operation is maintained at from 30:1 to as much as 50:1. Electrodes of 500 pounds and as small as .005″ diameter can be run on the same machine.

Circle No. **247** on Reader Service Card

Overhead buffer

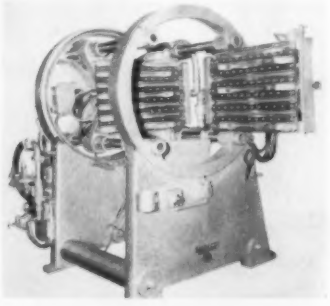
MURRAY-WAY CORP.—A three-wheel suspended work head buffs and polishes part curvatures not ordinarily reached by floor mounted heads the company reports. The compact unit has three buffing wheels driven by a single motor and is suspended from a mobile overhead wheel carriage.



Circle No. **248** on Reader Service Card

Shell core blower

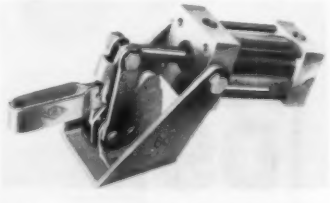
SHALCO DIV.—A new blower machine insures consistent quality shell core production, claims Shalco. Model U-180-M is a compact unit that requires an 8′x8′ installation area, and is available in right or left hand models so that one man can operate more than one machine at a time.



Circle No. **249** on Reader Service Card

Toggle clamps

DETROIT STAMPING CO.—De-Sta-Co toggle clamps are used in hard-to-reach areas and for rapid sequence of assembly operations on light metalworking jobs, the company said. A series of toggle clamps are available both air or hydraulic operated.



Circle No. **250** on Reader Service Card

more New Products on page 68

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*Compared against other popular materials.

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Circle No. **20** on Reader Service Card

LEVELMAX BRIGHT NICKEL

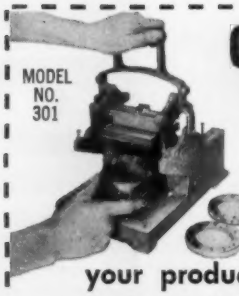
BRIGHT, HARD, SMOOTH FINISHES

on rough, dull, unbuffed surfaces

Levelmax — the bright nickel process — reduces or eliminates surface buffing and polishing, simplifies chrome plating, makes possible bright plating of hard-to-buff areas. You get bright, smooth nickel coatings on poorly polished steel, unbuffed stampings and castings and dull copper plate. Levelmax is simple to control, has high tolerance to organic and metallic contamination, can be used under standard plating conditions. Levelling action is excellent. Levelmax bright nickel takes chrome easily. The Levelmax process is the most versatile of the nickel processes for varied product shapes, base metals and applications.

For complete working details, write on your company letterhead for Bulletin 191, Levelmax operating manual. Write Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, N. Y., or call your nearest Federated sales office.

ASARCO



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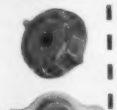

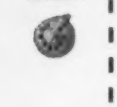

Model No. 301 is a hand operated machine adjustable for utmost perfection. Model No. 401A is the air-operated machine with that same precise touch and higher speed.

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Circle No. **2** on Reader Service Card

new products & developments

Continued

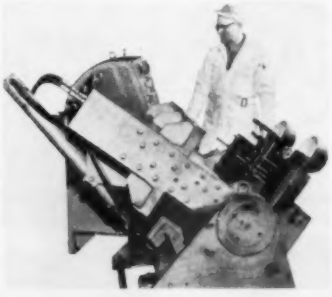
Tank cleaning compound

OAKITE PRODUCTS, INC.—Oakite HD 126 removes heavy soils by immersion, the company stated. The compound is said to have a pH of 13.5 in the recommended concentration, to be completely rinsable, and to be completely safe on steel brass, and magnesium, but not recommended for aluminum or zinc. It is used in barrel cleaning before plating.

Circle No. **251** on Reader Service Card

Permanent mold casting machine

STAHL SPECIALTY CO.—The Autocast permanent mold casting machine pours "two-up" with one man, eliminates turbulence,



and pours consistently at a given setting. The unit adjusts for any rate of pour, prevents flash at the bottom of the mold and assures progressive solidification, the company reported.

Circle No. **252** on Reader Service Card

Grinding coolant

SERVICE PRODUCTS DIV.—Mill Stream, a new grinding coolant for all metals, will grind metals and will not damage valves or other fittings in the coolant system, the company said. It is not to be used with magnesium or ductile iron.

Circle No. **253** on Reader Service Card

more New Products on page 70

The Abbot asks you: What's right for your product...

FINISH ...or CUT?

WHEN METAL PRODUCTS or parts need a polished, mirror-like, glass-hard *finish*, steel burnishing should be used . . . not synthetic abrasives, which have comparative application superiority only when *cutting* is what's wanted.

The high-quality steel shapes shown above on the top are products of the Abbott Ball Company, since 1909 the world's leading producer of steel finishing materials. Each different shape is designed for a special job.

SEND A SAMPLE of your product or part to us. Without charge, we'll conduct a thorough test and analysis on it, and return useful recommendations to you promptly.

Examining some samples after their test-run in the Abbott lab.

Write for copy of Bulletin AP-1

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Circle No. **90** on Reader Service Card

PRECISION METAL MOLDING

Helpful Hints for Die Casters

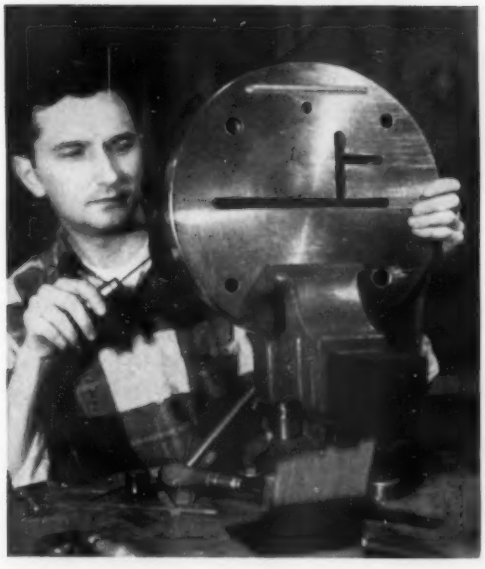
—from Bethlehem's Tool Steel Engineer

Double Tempering Reduces Heat-Checking in Hot-Work Steels

Double tempering has a beneficial effect on the service life of hot-work tools. The initial temper performs three jobs: it relieves quenching stresses, tempers the martensite, and conditions the austenite so that it will transform upon cooling. However, the second tempering operation provides additional benefits because it tempers the freshly formed martensite, giving the steel added strength and stability.

The double tempering of hot-work steels is widely practiced by the toolmaking industry. It reduces the danger of grinding cracks, and minimizes breakage in service.

Double tempering of hot-work steels helps avoid heat checks when a tool is first placed in service. By tempering the martensite, formed when the tool reaches room temperature after the first temper, the second temper minimizes the thermal shock of the initial service operations, and delays the development of heat checks.



Cromo-WV Upset-Forged Discs Wear Well at High Temperatures

Upset-forged discs made of Bethlehem Cromo-WV (H-12) tool steel are ideal for high-temperature extrusion work because of the long service they make possible. Their strength is enhanced by the flow lines generated in upsetting, and the hardness developed by heat-treatment, which is maintained at high operating temperatures. Bethlehem Cromo-WV discs also develop strong resistance to the effects of high-temperature service.

Cromo-WV is a wise choice for extrusions tooling because of its 5 pct chrome content, plus the balanced alloying of molybdenum, tungsten and vanadium. It resists heat-checking, and has good red-hardness, plus the ability to withstand shock applications.

Your Bethlehem tool steel distributor will be pleased to provide full information about upset-forged discs made of Cromo-WV. He can also give you advice concerning their use in specific applications.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
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Steel

For Strength
. . . Economy
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Circle No. 15 on Reader Service Card

new products & developments

Continued

Cemented tungsten carbide

ALLEGHENY LUDLUM STEEL CORP.—Three new grades of cemented tungsten carbides combine shock resistance with long wearing ability and make it easier for metalworking operators to pick the right cutting tool. The company reports that tool life is extended up to 200%.

Circle No. **259** on Reader Service Card

Rust inhibitor

THE SURFACE RESEARCH CORP.—BearCat BC-32, a non-oily type synthetic polymer rust inhibitor, can be used on investment casting surfaces. Paint is applied right over the inhibitor, and since the solution promotes paint adhesion, it can be used in place of a primer coat, the company said.

Circle No. **260** on Reader Service Card

Gas cooled heating units

ISPEN INDUSTRIES, INC.—Gas cooling with a fan for forced circulation is now incorporated

in its Automatic Vacuum Heat Treating Units. Ispen reported that metallurgical results are improved and production costs lowered.

Circle No. **261** on Reader Service Card

Temperature controls

WEST INSTRUMENT CORP.—Closer accuracy in temperature or other millivolt source control, announced the company, has

been made possible by the new line of Digital Set Point Controllers. The control point can be set in increments as small as one-half degree. The new series is available in single, dual or triple range models.

Circle No. **262** on Reader Service Card

Heat treating furnace

LINDBERG ENGINEERING CO.—A new full muffle hydrogen atmosphere furnace is used to bright heat treat the new aircraft and missile steels, stainless steels, and for brazing of stainless steels. It is said to heat to 2100°F.

Circle No. **263** on Reader Service Card

more New Products on page 72

ONE machine–ONE operator–ONE pass

Let's face facts—costs are high and will go higher. You can, however, *REDUCE* flat finishing costs with a Hammond Flat Finisher. Grinding, deburring, and finishing of flat surfaces of plates, printed circuits, bars, stampings, extrusions, etc., can be done uniformly on a high production basis with *ONE* machine . . . *ONE* operator . . . *ONE* pass.

Hammond Flat Finishers have the latest features: *automatic* belt tracking and oscillation, *automatic* air tensioning for abrasive belts and conveyor belt, *variable* speed conveyor, *ammeter* on each head, and other features which contribute to maximum production at lowest possible cost.

1 TO 6 HEADS
6" TO 12" WIDE

Available in 6", 8", and 12" widths

Send us one finished and a few rough samples so our engineers can analyze your finishing requirements. No obligation.

Hammond Machinery Builders INC.

1642 DOUGLAS AVE. • KALAMAZOO, MICHIGAN

See us at the ASTME Show, May 22-26, New York Coliseum

Circle No. **96** on Reader Service Card

Circle No. 94 on Reader Service Card

Break Through YOUR Production Barriers

Conforming Matrix Automatic Spray Finishing Machines, Electro-formed Masks, and Mechanical and Air Operated Fixtures permit production increases of hundreds to one over obsoleted hand methods.

Write for brochure or send prints or sample parts, giving production requirements and results desired.

Conforming Matrix CORPORATION

346 NEW YORK AVENUE
TOLEDO 11, OHIO
Telephone RA. 9-3777

specialists in metal surface treatments

KENVERT® Chromate Coatings, Bright Dips and Chemical Deburrings—Aluminum, Copper, Brass, Zinc, Cadmium, Zinc Die Castings

KENVERT Compatible Brighteners — Zinc, Cadmium

KENVERT Buffing Compound Removers
Synthetic Detergent Type — All Metals

CONVERT TO KENVERT ON DIE CASTINGS

Kenvert 45, a non-fuming pickle for aluminum castings; Kenvert 55, a chemical polish and burr remover for zinc die castings; Kenvert 11X, olive drab directly on zinc die castings; Kenvert ZB, tenacious direct chemical black; all available as powders.

Write for general summary Fact Sheet with details for over 50 products.

CONVERSION CHEMICAL CORPORATION
103 E. Main Street • Rockville, Connecticut
Phone: TRemont 5-3357

LICENSEES:
Nicromatic Ltd., Toronto, Canada
Silvercrown Ltd., London, England
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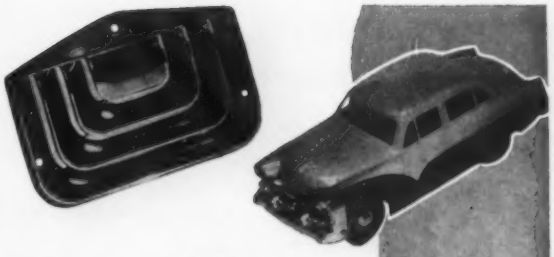
Circle No. 95 on Reader Service Card



FIORE MASKS FOR PRECISION PRODUCTION PAINTING

Spray decorating methods have improved so rapidly in recent years that you may not be aware of some time-saving, money-saving techniques now available. Today, special Fiore designed spray masks and fixture devices make possible single or multi-color decoration with precise registration on irregularly contoured products.

IF { your product is judged on appearance
you want best possible results
you want a minimum of rejections }
CONSULT US

Send for your FREE copy of our 20-page book which shows the different types of masks and gives case-study illustrations of their use. Or send your samples and drawings for consultation and estimates.

WM. M. FIORE INC.
269 41st Street Brooklyn 32, New York

Circle No. 101 on Reader Service Card

new products & developments

Continued

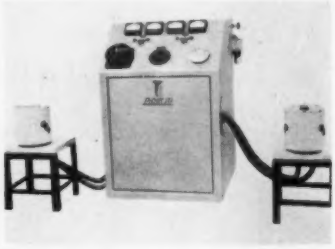
Profile grinder

STAR CUTTER CO.—Star No. 3 is a new floor-type tilting-table profile grinder used to grind and polish contours and irregular

shapes. It is ideally suited to work in tool and die shops, toolrooms and low-production operations, the company said. A grinding wheel is mounted on a vertical reciprocating spindle. It operates on wheel speeds of 4,500, 6,500 and 10,150 rpm.

Circle No. **264** on Reader Service Card

Induction heating system



INDUCTOTHERM CORP.—Inducto-Integral 15 is a new self-contained unit for high frequency induction heating and melting. The company reported that it requires less maintenance, gives more efficient power utilization and has greater operating continuity.

Circle No. **265** on Reader Service Card

Vibratory equipment

RAMPE MFG. CO.—The Vi-Brader is a new type of vibratory machine for precision tumble finishing and features a unique "controlled orbital motion." This feature is said to increase cutting speed up to 90% over conventional methods and provides longer tub life.

Circle No. **266** on Reader Service Card

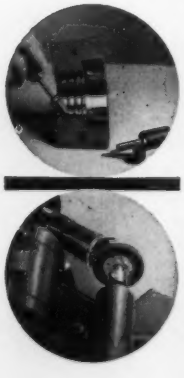
CRATEX RUBBERIZED ABRASIVES

re·li'a·ble: That which can always be counted upon to do what is expected or required

Micro-deburring, Smoothing, Cleaning, Polishing

Cratex reliability lowers costs

You can count on every Cratex item to perform just as you expect it to—exactly as the last one did and as the next one will. This is the key to efficiency in micro-deburring, smoothing, cleaning and polishing. YOU SAVE TIME because you know just what to expect in performance without experimenting or compensating. YOU SAVE REJECTS because with Cratex no unexpected irregularities occur to spoil work pieces.



WHEELS • POINTS • BLOCKS • STICKS • CONES in 4 grit textures for power or manual application. Sold through leading industrial supply distributors.

FREE! *Send for the complete CRATEX Industrial Catalog today*

CRATEX

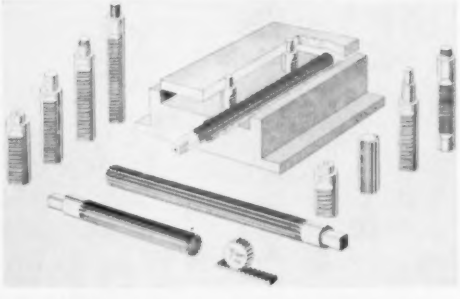
MANUFACTURING COMPANY, INC.

1800 Rollins Road Burlingame, California

Circle No. **100** on Reader Service Card

REDUCE COSTS WITH PEERLESS "FLAME-A-LOY"® PINIONS & RACKS

for DIE CASTING MOLDS • PERMANENT MOLDS • PLASTIC MOLDS



- Standardized Sizes From Special Toughened Alloy Steels
- Accurate Cut Racks To Match Pinions For Longer Wear Life
- Catalog No. 167A Available To Users

Established 1921 *Registered U.S. Pat. Office

PEERLESS GEAR & MACHINE CO., INC.

W. GENEVA AVE. • Phone: 3101 • DUNKIRK, OHIO

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Just a whisker away from five-9 purity

BUNKER HILL

special high grade (99.99+%) zinc

also...zinc base alloys

The first 99.99% zinc to be available on a commercial scale bore the famous name of BUNKER HILL.

Today, this time-honored brand, available from National Lead Company, analyzes very close to five-nine purity.

It is belaboring the obvious to point out the advantages of using metal with the lowest possible percentage of impurities.

When you buy Bunker Hill Special High Grade Zinc and Zinc Base Alloys from National Lead Company, you get the benefits of high purity . . . plus the distribution advantages inherent in National Lead's nationwide network of metal stocks. Profit by these extras . . . starting now!

Write, wire or phone nearest office

National Lead Company

General Offices: 111 Broadway, New York 6, N. Y. • Branches in principal cities

Circle No. 55 on Reader Service Card

All new from KUX

125 TON POWDER COMPACTING PRESS

6" die fill—full 125 tons ejection capacity

MODEL 1100

COMPLETELY AUTOMATIC

125 TONS COMPACTING PRESSURE APPLIED BY UPPER AND LOWER PUNCHES

125 TONS EJECTION PRESSURE

MASSIVE, ALL STEEL MAIN FRAME

RUGGED MECHANICAL TOGGLE OPERATION

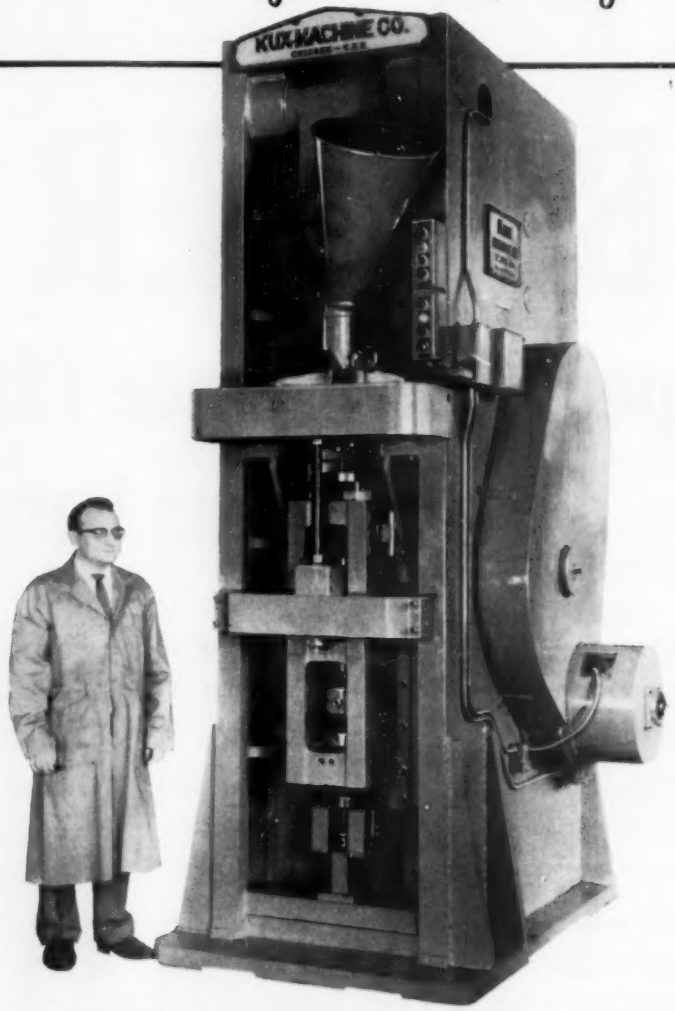
PRECISION PUNCH AND DIE ALIGNMENT

HEAVY DUTY STATIONARY CORE BRACKET

FLOATING CORE ROD WITH TIMING CONTROL

PUSH BUTTON—SINGLE CYCLE OR CONTINUOUS OPERATION CONTROL

SIMPLICITY OF ADJUSTMENTS—NO NEED FOR CAM CHANGES



Massive, all steel, heavy duty mechanical press for powdered metals, ceramics, plastic preforms, tungsten carbides and other powdered or granular materials. An unusual feature of this machine is its capacity to eject a compact with full 125 tons pressure. Both upper and lower punches apply pressure to the part being formed with capacity of up to 6" die fill and the machine is capable of making parts up to 6" diameter or length. Dwell under compression allows compact to set while under pressure. Floating core rod mechanism with up to 4" stroke and moving die table can also be incorporated.

KUX MACHINE CO. • 6725 NORTH RIDGE • CHICAGO 26, ILLINOIS

Circle No. 44 on Reader Service Card

PMM

data offered in this month's ads *qualified readers may obtain any of these free reference materials by circling the numbers on the reader service cards*

1. **Lubricants** — Acheson Colloids Co.—Bulletin No. 425 describes lubricants for metal casting, includes Dag 193 for permanent mold casting.
4. **Extrusion Alloys** — Aluminum Ltd. Sales, Inc. — List of independent aluminum extruders for individual areas.
6. **Iron Powders** — Alan Wood Steel Co. — Technical information on custom mixed blends and high-purity iron powders.
13. **Die Casting Machines** — B & T Machinery Co. — Information on a die casting machine with a superior hydraulic system.
14. **Compacting Presses**—Baldwin-Lima-Hamilton Corp. — Technical information on a line of compacting presses.
16. **Melting Furnaces** — Brown Boveri Corp. — Study shows results of furnaces in operation.
18. **Investment Casting** — Casting Engineers — 8-page Brochure tells how to specify for investment castings.
23. **Standard Unit Dies** — Detroit Mold Engineering Co. — Technical brochure describes how to lower die costs through standardization.
26. **Die Casting** — Dollin Corp. — Brochure describes facilities and services for zinc and aluminum die casting.
28. **Powder Metallurgy Equipment** — General Machine Co. of N.J. — Catalog describes equipment for blending, vacuum drying, and handling powdered metal.
30. **Lubricants** — Grafo Colloids Corp.—Booklet tells how to get "The Biggest Ounce of Protection" with dispersions.
32. **Small Die Castings**—Gries Reproducer Corp. — Bulletins list specifications and prices for small zinc die castings.
33. **Powder Metallurgy Equipment** —C. I. Hayes, Inc.—Details on sintering equipment to help solve heat treating and protective atmosphere problems.
36. **Investment Casting**—Hitchiner Mfg. Co. — Technical information on the ceramic shell method of investment casting.
38. **Powdered Metals** — Hoeganaes Sponge Iron Corp.—Booklet No. 128 describes facts about prealloyed stainless steel and other high alloy powders.
39. **Die Casting Machines** — Cast-Master, H-P-M Div.—Information on 100-ton to 2000-ton die casting machines.
43. **Melting Furnaces**—International Foundry Supply Co. — 20-page Brochure tells benefits of furnaces for continuous melting and holding.
46. **Heating Equipment** — Lepel High Frequency Lab., Inc. — Catalog lists complete line of high frequency induction heating units.
47. **Die Casting Machines**—Lester-Phoenix, Inc. — Bulletin 102 tells how to get better parts with the Certified Clamp on die casting machines.
56. **Metal Powders**—The New Jersey Zinc Co. — Brochure on "Designing For Pressed Brass and Nickel Silver . . ." powdered metal parts.

OFFERED FOR THE FIRST TIME . . .

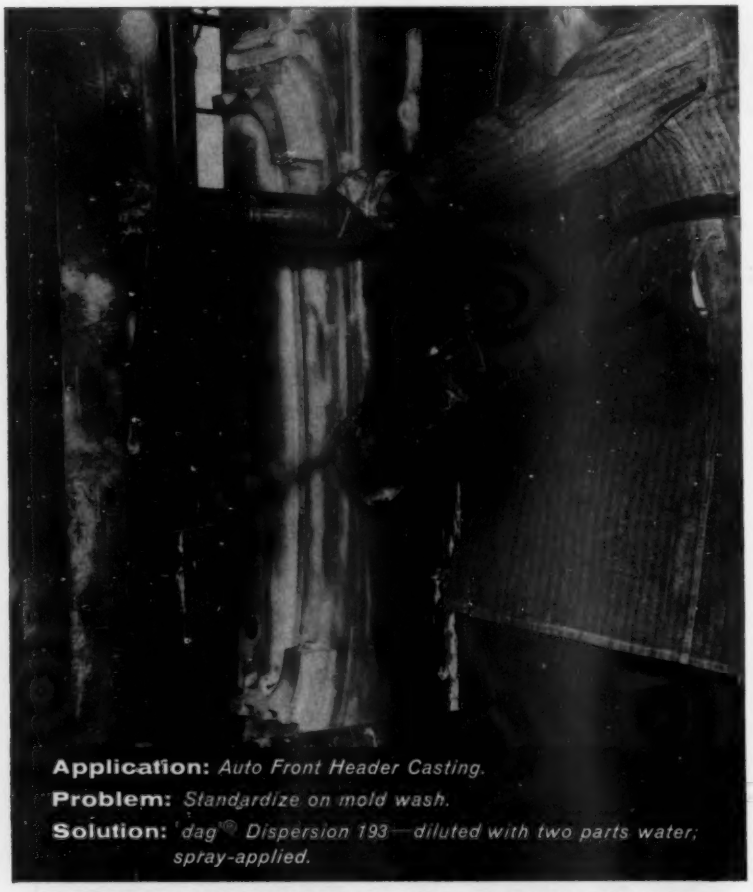
The services and reference materials listed here are being offered for the first time in this issue by new PMM advertisers.

20. **Cleaners, De-Oxidizers, Sealers** —The Chemical Corp.—Luster-on treatment is offered for aluminum finishes.
24. **Sintered Tools**—Diecraft Tool Co.—Carbide specialists offer sintered metal tools.
27. **Sintering Furnaces**—Drever Co. —Services are available for custom engineered sintering furnaces.
34. **Metal Powders** — Charles Hardy, Inc. — One source for all metal powders from aluminum to zirconium.
35. **Sintering Furnaces** — Harper Electric Furnace Corp. — Information on a complete line of sintering furnaces for all metals.
41. **Iron Powders** — A. Johnson & Co., Inc. — Information on a line of high-purity iron powders.
49. **Iron Powders** — Metal Powders Inc. — Offers MP.52 a new pre-alloyed sponge iron powder.
51. **Powder Metallurgy Equipment** — Mettler Instrument Corp. — Offers automatic checking and weighing equipment for powder metallurgy.
57. **Die Casting** — The Newton-New Haven Co. — announces a new die casting design.
58. **Extrusion Die Steel**—Marathon Specialty Steel Inc. — Offers a wide range of steel grades for extrusion die blanks.
59. **Lubricants** — M. W. Parsons-Plymouth, Inc. — Samples and data on metallic stearates used in powder metallurgy.
62. **Iron Powders** — Pyron Co. — Data sheets describe high grade iron powders.
- **Extrusions** — Rogers Industries, Inc. — Offer details on a versatile extrusion program of aluminum shapes. (Page 17-18)
76. **Metal Powders** — U.S. Bronze Powders, Inc. — Offers a complete line of metal powders.
82. **Powder Metallurgy** — American Sinterings — Mechanical properties sheet show test results on powder metal parts.
83. **Powder Metallurgy** — Brockway Pressed Metals, Inc. — Offer services for high speed production runs of powdered metal parts.
88. **Powder Metallurgy** — Norwalk Powdered Metals, Inc.—Folder tells how to convert powdered metal into machine parts.
101. **Painting Masks**—Wm. M. Fiore Inc. — 20-page Book shows different types of masks and gives case-study illustrations.
102. **Extrusions** — Kawneer Co. — Offers complete services from design to finished extrusions.
104. **Sintering Furnaces**—The Electric Furnace Co. — Bulletin No. 591 illustrates a complete line of powder metallurgy furnaces.
105. **Die Casting Equipment** — Advance Products Corp. — Offers machine accessories and rotary tables.
106. **Powder Metallurgy** — Haller, Inc. — Offer powdered metal parts producing services.
115. **Powder Metallurgy** — ASCO Sintering Corp.—Brochure describes money-saving advantages of powder metallurgy.

more Data on next page

DIE CASTING REPORT

(permanent mold)



Application: *Auto Front Header Casting.*
Problem: *Standardize on mold wash.*
Solution: *'dag'® Dispersion 193 — diluted with two parts water; spray-applied.*

RESULT: *CRITICAL CASTING QUALITY ASSURED BY SINGLE MOLD COATING*

The casting involved fits above the windshield on a luxury model convertible. It measures 61" in length, weighs 18 pounds after trimming. 1/16" tolerances must be held in each dimension, with a surface finish of 80 microinches maintained. Many mold coatings, from a variety of sources, were evaluated by Enterprise Brass Works, Muskegon, Michigan, but none proved acceptable. By adopting 'dag' 193 as their mold wash they achieved:

1. "packaged" uniformity — no variation between applications
2. better insulation and release characteristics
3. longer-lasting effectiveness in the mold — up to 300 units, 40 hours of operation, per application

As a guide toward increased effectiveness in your metal casting operations, we invite you to send for your copy of Bulletin No. 425. Address Dept. PMM-41.

ACHESON — First name in solid lubricants for fifty-three years.

ACHESON Colloids Company

PORT HURON, MICHIGAN

A division of Acheson Industries, Inc.

Sales offices in principal cities.

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

Circle No. 1 on Reader Service Card

data in ads

Continued

60. **Pinions and Racks** — Peerless Gear & Machine Co. — Catalog describes pinions and racks for users of die casting and permanent molds.
61. **Lubricating Equipment**—Pierce-Waller, Inc.—Information on a system for lubricating, cleaning and cooling mold cavity surfaces.
63. **Powder Metallurgy** — Reese Metal Products Corp. — 16-page Booklet tells how to cut parts costs by the Remet process.
64. **Aluminum Casting Alloys** — Reynolds Metals Co.—Brochure TENS 50 describes new high strength aluminum casting alloy for permanent mold and investment casting.
66. **Waxes**—Alex. Saunders & Co., Inc.—Bulletins, technical information on investment casting waxes and other materials.
67. **High-Purity Nickel** — Sherritt Gordon Mines Ltd.—Brochure on high purity nickel.
68. **Lubricants** — G. W. Smith & Sons, Inc. — Data file on Die Slick lubricants, also free sample of plunger lubricants.
69. **Die Casting** — Southern Die Casting & Engineering—Information on complete designing and engineering services for die casting parts.
71. **Compacting Presses** — F. J. Stokes Corp.—Technical information on a complete line of compacting presses.
73. **Pots**—The Tiffin Foundry Inc. —Brochure lists a complete line of stock pots.
75. **Palletainers** — Union Steel Products Co. — Information on palletainers used to ease die casting handling problems.
77. **Metal Powders** — Vanadium-Alloys Steel Co.—Details on a complete line of pre-alloyed powders and names of fabricators of magnetic alloy parts.
78. **Investment Casting**—Vascoloy-Ramet Co.—Booklet shows the design flexibility of investment casting.
79. **Temperature Control Equipment**—West Instrument Corp.—40-page file-size Catalog lists thermocouples for standard temperature indicators, controllers, and recorders.
85. **Tool & Die** — Gentry Carbide Tool & Die Co.—6-page Brochure describes facilities and carbide tools and dies.
89. **Powder Metallurgy** — Merriman Bros., Inc. — Technical Catalog on quality, accurate powder metal parts.
90. **Steel Finishing Balls** — Abbott Ball Co. — Technical bulletin AP-1 describes barrel finishing media for producing mirror-like finishes.

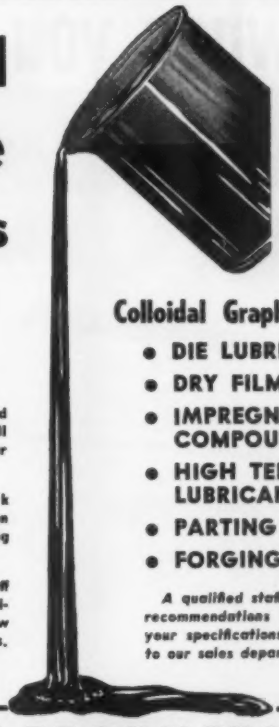
91. **Chromate Coatings** — Allied Research Products, Inc.—Technical booklet on the Iridite line of chromate conversion coatings for non-ferrous metals.
92. **Barrel Finishing** — Almco, Queen Products Div., King-Seeley Corp. — 52-page engineering Manual on barrel finishing includes case histories.
94. **Spray Painting** — Conforming Matrix Corp. — Brochure describes spray finishing machines, masks, and fixtures.
95. **Chromates, Brightners, Detergents** — Conversion Chemical Corp. — Fact sheet describes products for die casting surface treatment.
97. **Fluxes**—Haviland Products Co. —Brochure on zinc and aluminum fluxes.
98. **Metal Cleaners**—Oakite Products, Inc. — Bulletin 9651 describes an alkaline material for removing rust and scale.
99. **Spray Paint Finishes** — Ransburg Electro-Coating Corp. — No. 2 process Brochure tells of an automatic process for electrostatic spray painting.
100. **Abrasives** — Cratex Mfg. Co., Inc.—Catalog on a line of rubberized abrasives for deburring, smoothing and cleaning.
103. **Die Casting Dies** — Richards Tool & Mold Co.—Information on how Master-Molds eliminate expensive die sets.

Colloidal Graphite dispersions

can help you

3 WAYS:

1. **Production — For established production processes we will prepare dispersions to meet your specifications.**
2. **Development — We will work directly with your engineers on development projects requiring specialized dispersions.**
3. **Research — Our research staff is always available for consultation on new products, new processes and new applications.**



Here are a few uses of

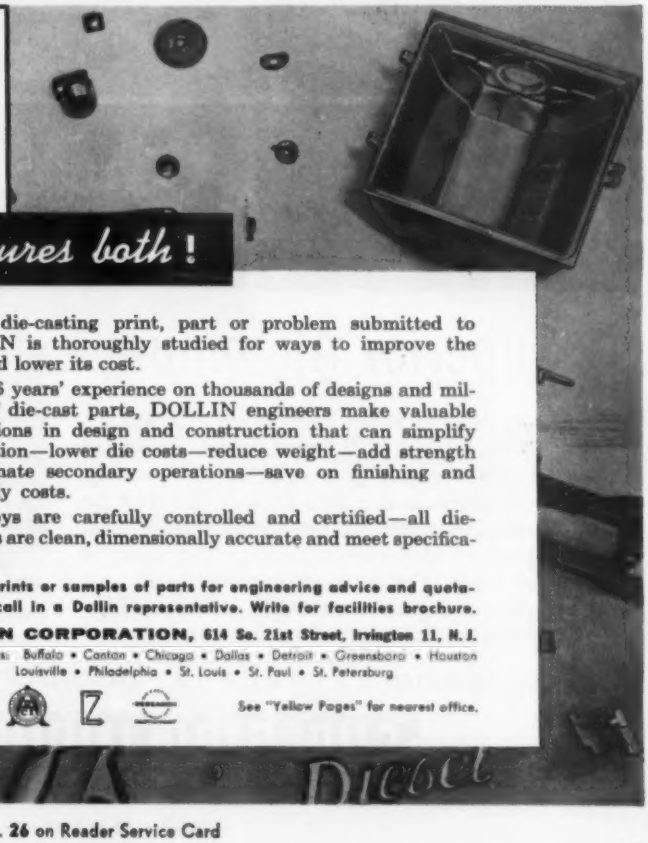
Colloidal Graphite Dispersions:

- **DIE LUBRICANT**
- **DRY FILM LUBRICANT**
- **IMPREGNATING COMPOUND**
- **HIGH TEMPERATURE LUBRICANT**
- **PARTING COMPOUND**
- **FORGING COMPOUND**

A qualified staff is available for prompt recommendations and quotations to meet your specifications or preliminary inquiries to our sales department.

GRAPHITE PRODUCTS CORP.
BROOKFIELD, OHIO

The RIGHT DIE-CASTING
is as important as
the RIGHT PRICE



DOLLIN *assures both!*

Every die-casting print, part or problem submitted to DOLLIN is thoroughly studied for ways to improve the part and lower its cost.

With 26 years' experience on thousands of designs and millions of die-cast parts, DOLLIN engineers make valuable suggestions in design and construction that can simplify production—lower die costs—reduce weight—add strength —eliminate secondary operations—save on finishing and assembly costs.

All alloys are carefully controlled and certified—all die-castings are clean, dimensionally accurate and meet specifications.

Submit prints or samples of parts for engineering advice and quotation, or call in a Dollin representative. Write for facilities brochure.

DOLLIN CORPORATION, 614 So. 21st Street, Irvington 11, N. J.

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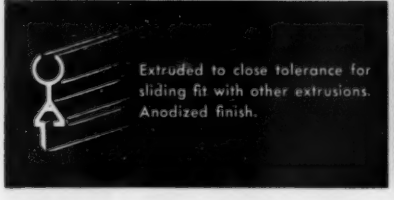
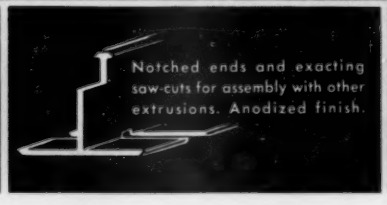
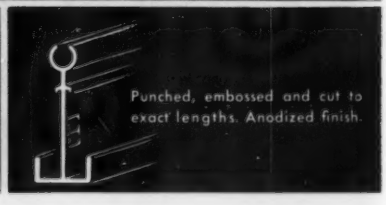
See "Yellow Pages" for nearest office.

DOLLIN
Zinc and Aluminum
DIE-CASTINGS

when you design a new product, remember...







Superior Aluminum Extrusions always fit!

Every piece of Superior aluminum extrusion fits perfectly into a J. A. Wilson Lumatrax suspended light diffusing unit, pictured in the above ceiling. Every extrusion has been factory checked for "customer-specified" tolerances. This is most important with Lumatrax since units must be fitted together in the field. The consistent uniformity of Superior extrusions meets the exacting demands of modern production lines and the high quality requirements of today's products.

Superior craftsmen miter, bend, rivet, drill, countersink and notch, as well as paint, polish, anodize and etch the metal, all under one roof. No wonder companies everywhere are talking about Superior's cost savings, complete services and splendid workmanship.

Send us samples, blueprints, or ask us to call. Superior engineers are ready to help you in many ways.

ALUMINUM EXTRUDERS • ANODIZERS • ARTRIM MOULDINGS

SUPERIOR INDUSTRIES INC.

3788 OAKWOOD AVENUE • YOUNGSTOWN, OHIO

Circle No. **72** on Reader Service Card

PMM

useful literature, catalogs, manuals *qualified readers may obtain any of these technical publications by circling the numbers on the reader service cards.*

PROCESSES

163 *Investment Casting*—ENGINEERED PRECISION CASTING CO.—4-page technical Bulletin describes the features of shell mold investment casting.

164 *Sintering*—SINTERCAST DIVISION—12-page Manual gives technical information on steel-bonded carbides that are used as tool materials.

165 *Die Casting*—FALCONER METAL SPECIALTIES CO.—facilities Brochure describes design and manufacture of zinc and aluminum die castings.

166 *Die Casting*—FOUNDRY SERVICES, INC.—4-page Bulletin discusses gas porosity in aluminum castings and lists degasers.

167 *Extruded Aluminum*—HARVEY ALUMINUM—Guide for deep-drawn hollow extruded aluminum bar stock gives technical information for machining applications.

168 *Die Castings*—HADLOCK & TEMTE, INC.—facilities Brochure describes precision miniature die casting with parts held to close tolerances at a minimum cost.

169 *Die Casting*—NEWTON-NEW HAVEN CO.—6-page facilities Brochure describes in detail complete facilities for design and production of aluminum and zinc die castings.

MATERIALS & EQUIPMENT

174 *Heating Equipment*—AJAX MAGNETHERMIC CORP.—8-page technical Bulletin describes a line of induction heating and melting equipment including information on low and high frequency melting and billet heaters.

175 *Packaging Die Castings*— W. J. BRADFORD PAPER CO.—6-page Brochure tells how properly designed cardboard cartons, correctly partitioned, offer greatest protection for shipping products such as die castings.

176 *Selector, Tube-"O" Ring*—THE ADVANCE PRODUCTS CO.—easy to use Selector for determining tube seals with plain and coated metal "O" rings.

177 *Selectors, Tool Steel*—THE ALLEGHENY LUDLUM TOOL STEEL CORP.—Brochure and Steelector cards for easy file and identification of the various grades of tool steels.

• ***Calculator, Drills*—**KELM MANUFACTURING CO. —slide-rule type Calculator gives shrinkage and draft for drills, available from Kelm Mfg. Co., Route #2, Coloma, Mich. for $2.00.

178 *Selector, Aluminum*—WABASH SMELTING INC. —slide-rule Selector for determining common designations of 59 aluminum alloys used in the die casting and permanent mold industries.

179 *Vacuum Equipment*—KINNEY VACUUM DIVISION —Report No. 5 gives application of vacuum equipment, including a furnace for melting and casting, and also sintering.

180 *Die Steels*—VANADIUM-ALLOYS STEEL CO.—12-page Brochure lists technical data for plastic die steel grades.

181 *Beryllium Oxide*—BRUSH BERYLLIUM CO.—12-page Brochure gives technical information on beryllium oxide.

182 *Steel Alloys*—CLIMAX MOLYBDENUM CO.—77-page revised Guide shows how to combine design, proper selection and good treatment of die steels for optimum performance.

• ***Vacuum Equipment*—**NRC EQUIPMENT CORP.—Catalog on high-vacuum components and equipment on letterhead request to: 160 Charlemont Street, Newton 61, Mass.

184 *Lubricants*—E. F. HOUGHTON & CO.—Data sheets describe die release agents for die and permanent mold castings.

185 *Die Casting Fluxes*—APEX SMELTING CO.—8-page Booklet describes how fluxes aide die casters in the production of aluminum castings.

186 *Die Cooling Fittings*—PAR-VIN CO.—Leaflets list specifications for a standard line of water cooling fittings for cooling die casting dies.

187 *Vacuum Furnaces*—CONSOLIDATED VACUUM CORP.—24-page Book on application of vacuum metallurgy and operation of vacuum furnaces.

188 *Powder Metallurgy*—VANADIUM-ALLOYS STEEL CO.—Brochure and data sheets give technical information on a variety of tool steels for powder metallurgy.

more Useful Literature on page 81

Switching from aluminum to Zamak sliced casting costs in half on this Whitehead ball bearing bobbin holder. And with seven zinc die castings accounting for all the major working parts, overall costs dropped a neat 12%.

This high volume item is found on spinning frames in cotton mills—it's designed to take twenty to thirty years of rugged, day-in day-out service. Yet by using Zamak instead of aluminum, the wall thickness of certain parts was reduced from .065" to .050". This resulted in a decrease in material cost with no loss in strength. Whitehead Die Casting plans to bring their costs down still further by going to wall thicknesses of .032"—with the toughness of the parts still unaffected as far as their performance goes.

Besides the healthy cost savings directly related to the reduced wall sections, Zamak also provides Whitehead with a familiar success story—"faster and more economical production . . . longer die life . . . less rejects." Zamak gives you more for less — — —

WHITEHEAD BALL BEARING BOBBIN HOLDER

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THE NEW JERSEY ZINC COMPANY'S "DIE CASTING OF THE YEAR" COMPETITION

CASTING COSTS CUT 50%

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HORSE HEAD PRODUCTS

Circle No. 86 on Reader Service Card

useful literature, catalogs, manuals

Continued

189 *Heating Equipment*—STA-WARM ELECTRIC CO.—Data file on a full line of heating equipment for melting compounds.

190 *Pneumatic & Electric Controllers*—MINNEAPOLIS-HONEYWELL REGULATOR CO.—56-page Catalog covers a complete line of controllers.

191 *Powder Metallurgy*—THE ELECTRIC FURNACE CO.—16-page technical Bulletin tells how to design powdered metal parts, lists engineering data and gives furnace information.

192 *Powder Metallurgy*—AMPLEX DIVISION—18-page Brochure lists technical information on 1066 standard bearing sizes available, made by powder metallurgy.

194 *Metal Alloys*—CHASE BRASS & COPPER CO.—16-page Directory of products and services including all metals, product literature, films and sales helps.

195 *Iron Powders*—ANTARA CHEMICALS—28-page Brochure tells how carbonyl iron powders are used, chiefly in the production of high-frequency cores.

196 *Jigs & Fixtures*—ACCURATE BUSHING CO.—Literature on a complete line of jigs and fixture components.

199 *Spray Lubricating*—RENITE CO.—Brochure and technical data on an automatic spray-lubricating unit for lubricating dies, molds, punches, mandrels, etc.

FINISHING

205 *Abrasion Protection*—ELASTICONE DIV.—Bulletin explains how production tools and manufactured products can achieve longer working life with less maintenance by installing a protective cone over wearing parts.

206 *Tin Coating*—SHIPLEY CO., INC.—Data describes a chemical process for tin dip coating.

207 *Tools*—PLEW TOOL CORP.—24-page Catalog describes a complete line of cold-heading, forming and cutting tools.

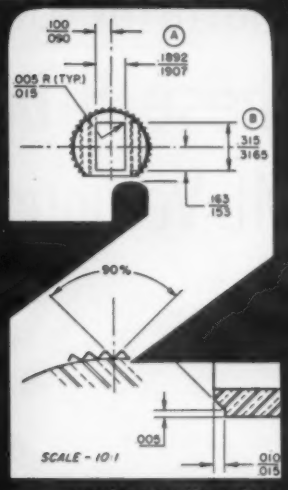
208 *Plating Compounds*—METAL & THERMIT CORP.—Brochure describes a line of compounds for replenishing decorative chromium plating solutions and for controlling fumes.

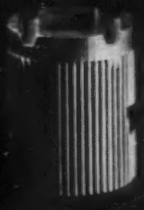
209 *Barrel Finishing*—THE BAIRD MACHINE CO.—Brochure describes a complete line of barrels and barrel finishing equipment.

210 *Cleaning Compound*—ENTHONE, INC.—Leaflet gives information on a powdered alkaline product for spray wash cleaning of castings.

more Useful Literature on page 83

BLUEPRINT FOR





Transforming these lines and numbers into the functional reality of a sintered brass brush holder for small electric actuator motors took teamwork. A design engineer conceived it, and a metal powder fabricator brought it to fruition—at a 65% cost saving over the previous method of manufacture.

It might not have been this way. Despite a design engineer's careful planning, his blueprint could be a neatly drawn recipe for an ulcer – when looked at by a metal powder fabricator aware of the advantages and limitations of his art. Often, a fabricator has little choice but to turn out a part he knows could be made infinitely better—could be made with increased reliability, more wearability, less machining and lower costs.

Working together, the metal powder fabricator and design engineer make economical mass production of critical parts a reality. And we also mean "critical" in the sense that a whole is no better than the quality of its most prosaic part. For more information about the design, application and advantages of nonferrous metal powder parts, write today to The New Jersey Zinc Company for your copy of "Designing For Pressed Brass and Nickel Silver Parts."

Part by KWIKSET POWDERED METAL PRODUCTS
Division of American Hardware Corporation

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DEVELOPERS OF BRASS & NICKEL SILVER POWDERS SETTING TODAY'S STANDARDS

HORSE HEAD PRODUCTS

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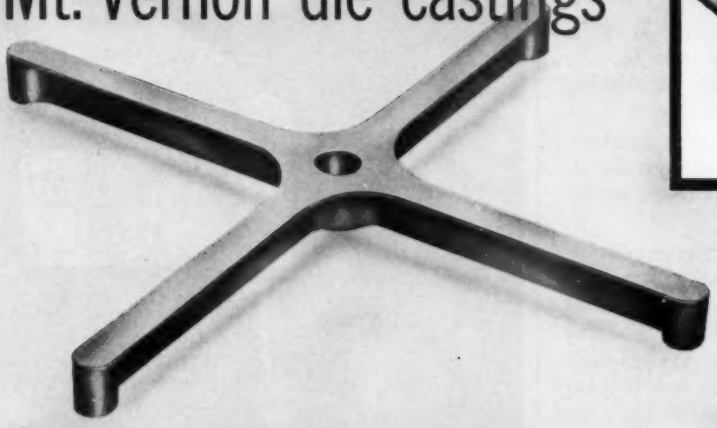
Steel furniture manufacturer gets **these 5 benefits** from Mt. Vernon die castings



CASE HISTORIES FROM MT. VERNON FILES

Subject:

Art Steel Company, New York City

In a major switchover, Art Steel Company makes this handsome Steelmaster Desk with aluminum die cast legs. The companion Executive Chair stands on a die cast aluminum base. Formerly it took 8 parts to assemble each island leg of the desk . . . and 14 parts for the chair base. But switching to die cast parts gave Art Metal Company 5 major benefits:

1. Simpler fabrication since all castings are one-piece integral units. No more multiple section subassembly work.

2. Complete freedom in designing due to the many inherent advantages of the die casting process.

3. Corrosion of legs and bases caused by office cleaning detergents no longer a problem. Aluminum die castings stay bright and attractive.

4. Die castings are delivered polished, drilled and tapped, ready for use. Several assembly steps previously required have been eliminated.

5. Because production of legs and bases has been put into Mt. Vernon, valuable production capacity at Art Steel has been freed for other requirements.

More and more, in a great variety of products, Mt. Vernon Die Castings are replacing complex sheet metal assemblies and costly, crude sand castings, bringing significant production economies to the manufacturer. All the knowledge we have gained on this subject is also available to you . . . free. Why not discuss your problem with us too. A call to your nearest Mt. Vernon representative will bring you action.

MT. VERNON DIE CASTING CORPORATION
STAMFORD, CONNECTICUT

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BALTIMORE, MD.: Mr. C. M. Gordan, 919 St. Paul St.
BROOKLYN, N. Y.: Mr. Robert V. Moore, 2317 Plumb 2nd St.
CLEVELAND, OHIO: Mr. Grant Eller, 6 East 194th St.
MARIETTA, N. Y.: Mr. Burt J. Meldrum, Olanco Road
PITTSBURGH, PA.: Mr. Andrew W. Anderson, 300 Pasadena Drive So.
STAMFORD, CONN.: Mr. Anker Anderson, Cascade Road
VALLEY FORGE, PA.: Mr. G. T. McMaster, P.O. Box 115

Circle No. 54 on Reader Service Card

useful literature, catalogs, manuals

Continued

211 *Barrel Finishing*—PANGBORN, CORP.—Bulletin on five heavy-duty blast cleaning barrel finishing machines with work capacities from 15 to 102 cubic feet.

212 *Paint Spray Finishing*—OAKITE PRODUCTS, INC.—Folder tells how to treat water in paint spray booths.

213 *Die Casting Finishes*—MACDERMID INC.—technical data Sheets list aluminum etch compounds which vary the finishes on castings.

214 *Belt Sanders*—THE CARBORUNDUM CO.—Brochure describes a series of abrasive belt sanding machines.

215 *Paint Spray Finishes*—CONFORMING MATRIX CORP.—Brochure describes five automatic machines for washing spray paint masks.

216 *Buffing Machines*—PACKER MACHINE CO.—Literature gives information on eight basic types of automatic polishing and buffing machines.

218 *Die Casting Equipment*—SERVICE MACHINE & SUPPLY CO.—Brochure describes advantages of trim die service, stud driving machines, die casting straighteners and a vertical belt sander.

Circle No. 97 on Reader Service Card

"IF YOU'RE MELTING ALUMINUM OR ZINC—

I'LL SHOW YOU HOW TO SAVE UP TO 50% ON FLUX!"

That's right. Haviland's 4-B for Aluminum or 3-G for Zinc can save you up to 50% on Flux costs. How? By separating four times more metal from dross with Haviland fluxes. Many of our customers have found Haviland-separated dross is so low in metal content that pulverizing or mechanical separation is unnecessary . . . and they're getting better alloys, too. Haviland Flux is: FAST — even at lower furnace temperatures where other fluxes might fail. SAFE — less dangerous acrid or stinging fumes.

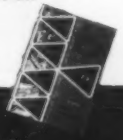
USE HAVILAND 4-B ALUMINUM FLUX

- Greater metal-dross separation
- Works at lower temperature (1250° F)
- Essentially smokeless
- Pulverizing or mechanical separation unnecessary
- Safe in any type of furnace

USE HAVILAND 3-G ZINC FLUX

- Complete metal-dross separation
- Economical — less flux required
- Safe in any type of furnace
- Essentially smokeless

Write for complete information and fluxing procedures.



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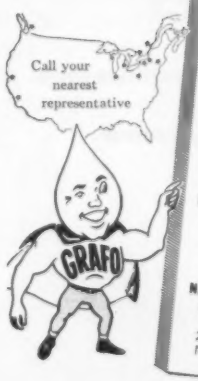

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GRAFO COLLOIDS *Corporation*

289 Wilkes Place, Sharon, Pa.

Circle No. 30 on Reader Service Card

news of industry & associations

Continued from page 23

International Powder Metallurgy Co., Inc.—*Antony J. Zino, Jr.*—has been elected vice president sales.

National Lead Co.—*Emmett A. Torney* has been made sales manager of primary metals for the Metal Division.

Foundry Services, Inc.—*Douglas B. Beath* has been appointed sales manager of the Foundry Division. *Albert G. Eschrich* has been named technical sales representative for southern Illinois, Missouri and eastern Kansas.

BEATH

ESCHRICH

Mid-East Aluminum Corp.—*C. Lawrence Dey* has been placed in charge of product development of new aluminum extrusion uses for the electronics industry. *Donald Manning* has been named to direct industrial sales in the Philadelphia-Camden and central New Jersey area. Frank English has been appointed production control manager for direct production scheduling and inside engineering.

Metals and Refractories Div., Howe Sound Co.—*Roger J. Metzler* has been named assistant to the general manager.

METZLER

PAYNE

Precision Castings Co.—*Robert W. Payne* has been made sales administrator at the Cleveland Division.

Schwarzkopf Development Corp.—*Jordan Jablons* has been elected executive vice president.

P. R. Mallory & Co. Inc.—*Albert S. Humphrey* has joined the company as manager—research planning.

Raymond F. McHugh & Son—*Henry Byrne* has been named general sales manager.

Newton-New Haven Co.—*Jerome J. Theobald, Inc.* has been announced as its exclusive sales representatives for the upper New York state area.

Zinc Development Association—Lead Development Association—*R. Lewis Stubbs*, director of the Zinc Development Association, has been appointed director-general of both organizations.

Denison Engineering Div., American Brake Shoe Co.—*Phillip Shrider* has been named field engineer and will supervise sales of Denison pumps and controls in upper New York.

SHRIDER

SHACKETT

Gorham Electronics Div., Gorham Mfg. Co.—*Cornelius J. Shackett* was named production control manager.

more Industry News on page 86

KAWNEER EXTRUSION FACILITIES

- Complete billet casting facilities up to 9 inches
- Quantometer for quality control
- Homogenized billet
- Multi-press operation
- 25-foot anodizing tanks
- Unsurpassed service
- Over 50 years experience

ONE SOURCE FROM DESIGN TO FINISHED EXTRUSION

Your inquiry will receive prompt attention.

Kawneer Co.
MILL PRODUCTS DIVISION
St. Charles, Ill. CHICAGO PHONE: MA 6-2287

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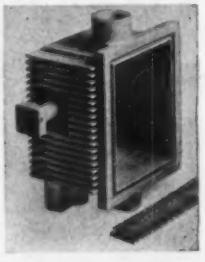
Precise Investment Casting for High Production! Fine Finish! Low Reject Rate!



LIEBROS CASTING CO., INC.

Saunders Investment Casting Materials help you make Precise Investment Castings. Intricate parts with cores, under-cut sections, etc., can be cast in one piece at one time! Production can be increased, tolerances held closely with fine surface finish.

Sherwood Wax Injection Presses work at lower temperatures to give precise pattern production — Saunders "Blue Wax" has high tensile strength, hard surface and low ash content to give castings a better surface finish and reliable adherence to tolerance. High Quality Refractory Materials offered for shell or monolithic molds. Complete plant set-up for precision investment casting available including Ovens, Fluidized Beds, Turntable Mixers and melting equipment.

Write for information today, — latest bulletins or complete catalog.

Alexander Saunders & co., INC.
95 Bedford Street, New York 14, N. Y.

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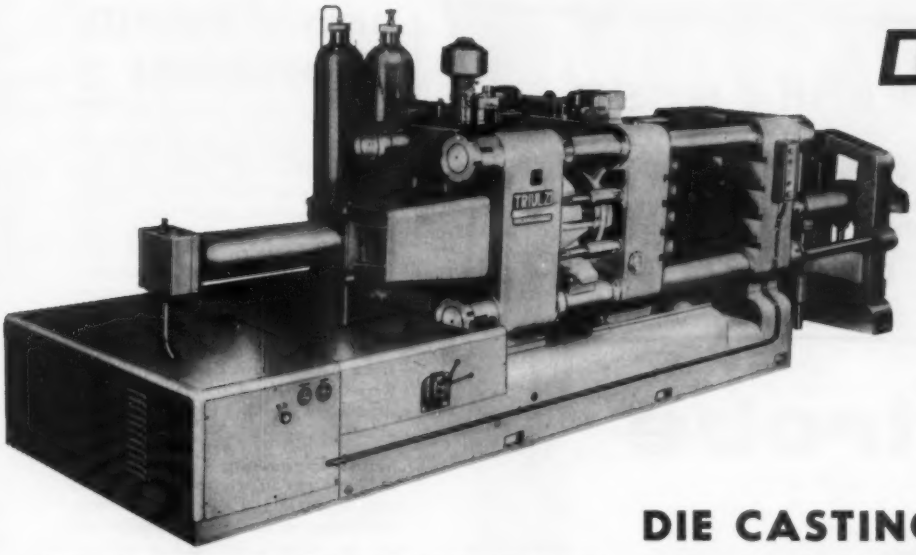
castmatic



Model 700 T.
cold chamber

- oil hydraulic
- automatic
- platens adjusted by motorized central screw
- schedules pre-selecting panel
- working speeds up to **660 dry cycles per hour**

DIE CASTING MACHINES

- **cold chamber, horizontal and vertical from 135 to 2500 U.S. Tons**
- **hot chamber, from 135 to 1100 U.S. Tons**

Characteristics	Mod:	150	500	700	1,000
Max. shot capacity (Al.)	pounds	3.0	11.9	18.7	31.5
locking force	U.S. Tons	165	550	770	1100
Max. Thickness of the die	inches	24	29.5	22	39.5
platens adjustment	inches	14	18	8	20
opening stroke	inches	12	18	26	27.5
dry cycles	per hour	380/550	350/450	250/400	250/360

VISIT US AT THE MILAN FAIR, April 12-27, 1961
Pavilion 17, Stands 17411, 17469, 17471, and Hall C (outside of Pavilion 17).

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PUMPS and water hydraulic plants

Model Z/250
hot chamber

- oil hydraulic
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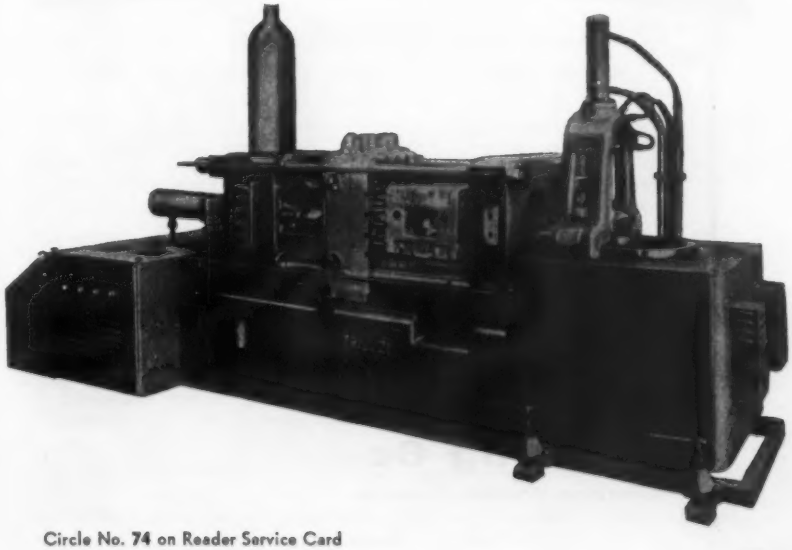
- schedules pre-selecting panel
- working speeds up to **800 dry cycles per hour**



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Begin with the
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Latrobe
Die
Casting Co.
Latrobe, Pennsylvania

Established 1918

Circle No. 45 on Reader Service Card

news of industry & associations

Continued

American Refractories & Crucible Corp.—*Robert M. Terry* has been elected president and treasurer; *Richard L. Matthies*, secretary. Other elected officers are: *Bernard H. Matthies*, vice president; *George H. Caligan*, vice president in charge of sales; *Perry McCollom*, assistant secretary; and *Eugene R. Crandall*, assistant treasurer.

Bohn Aluminum & Brass Corp.—*J. J. Keras Sales Co.* has been appointed sales agent covering the mid-Southern area.

Sutton Engineering Co.—*Robert L. Hibbard* has joined the company as staff engineer and will assist in product design of automation equipment.

The Diversey Corp.—*W. C. Thompson* has been named assistant manager, Metal Industries Department.

May meeting set for AZI

The American Zinc Institute will hold its 43rd annual meeting at the Drake Hotel in Chicago on Monday and Tuesday, May 1 and 2.

The first session will be held Monday morning in conjunction with The Galvanizers Committee of the steel industry (sponsored by AZI). The second session will be devoted to zinc industry matters. The third session will be conducted jointly with the Lead Industries Association, Tuesday morning and will cover matters of interest to the zinc and lead industries.

May will be month for annual Design Show

The conference and Design Engineering show will take place at Cobo Hall in Detroit from May 22-25. Of major interest will be the reports from automobile company executives on how the companies measure and meet public tastes in cars.

More information is available from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N.Y.

India extruders to get 3300-ton press

A 3300-ton hydraulic self-contained aluminum extrusion press

operating at 2750 psi, made by the Watson-Stillman Press Division of Farrel-Birmingham Co., Inc., will be installed in India. Two detwisting type stretchers, in capacities of 100 and 25 tons and a 100 ton straightening press, are included.

Lee Silver joins Jervis

Jervis Corp. announced that they have bought Lee Silver Service, Inc. Leo Radke, president of Lee Silver Service, will join Jervis' board of directors.

Alphatizing developers bought by Soundcraft

Reeves Soundcraft Corp. announced the purchase of Alloy Surfaces Co. developers of Alphatizing, a gaseous chromium diffusion process.

Hazard E. Reeves, president of Soundcraft, said that the Alphatizing process of Alloy Surfaces Co., announced last year, gives stainless steel properties to ordinary steel at a fraction of the cost of solid stainless steels.

One company, the Hoeganaes Sponge Iron Corp., has received an exclusive license for the Alphatizing of powdered metal and powdered metal parts.

Jelrus adopts new name

Jelrus Precision Casting Co. has adopted its parent company name, Casting Engineers. The investment caster will continue manufacturing operations in New York, although sales will be handled through the Chicago facilities.

New firm works with specialty metals

A new metalworking company will operate in the field of specialty metals and their application. The firm, Metalonics Corp. uses a versatile 800-ton extrusion press and has acquired specialized equipment for drawing, coiling, cutting and straightening. Initial operations will be centered about the extrusion of high performance and clad metals in the form of rod and special shapes. Tubing is expected to be added at a later date.

MARVEL
SYNCLINAL FILTERS

FOR DEPENDABLE PROTECTION on all Hydraulic and other low pressure circulating systems

Designed to give more ACTIVE filtering area—MORE dependable protection—MORE productive operation before cleaning is necessary. *Meet J.I.C. Standards.*

Synclinal SUMP TYPE

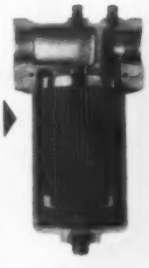
CAPACITIES: 5—8—10—20—30—50—75 and 100 G.P.M.
PIPE SIZES: ¾"—1"—1¼"—1½"—2"—2½" and 3".
CONNECTIONS: Coupling—Male Nipple.
BY-PASS VALVE: Not Available.

Synclinal LINE TYPE

CAPACITIES: 5—8—10—20—30—50—75 and 100 G.P.M.
PIPE SIZES: ¾"—1"—1¼"—1½"—2"—2½" and 3".
BY-PASS VALVE: Not available.
OPERATING PRESSURES: Up to 80 p.s.i.

Bonded SUMP TYPE

CAPACITIES: 10—20—30—50 and 75 G.P.M.
PIPE SIZES: 1"—1¼"—1½"—2"—and 2½".
CONNECTIONS: Coupling—"O" Ring—Male Nipple.
BY-PASS VALVE: Available with or without

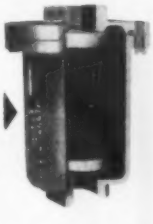


Bonded LINE TYPE

CAPACITIES: 10—20—30—50 and 75 G.P.M.
PIPE SIZES: 1"—1¼"—1½"—2" and 2½".
BY-PASS VALVE: Available with or without.
OPERATING PRESSURE: Up to 250 p.s.i.
OPERATING TEMPERATURES up to 300° F.

Tandem SUMP TYPE

CAPACITIES: 10—16—20—40—60—100—150 and 200 G.P.M.
PIPE SIZES: ¾"—1"—1¼"—1½"—2"—2½" and 3".
CONNECTIONS: Coupling—Male Nipple.
BY-PASS VALVE: Not available.



IN-LINE FILTER

CAPACITIES: Up to 60 G.P.M.
PIPE SIZES: ¾"—1"—1¼" and 1½" (at both inlet and outlet).
BY-PASS VALVE: Available with or without

FILTERING MEDIA in all Marvel Filters is Monel wire cloth available in mesh sizes of 30-40-50-60-80-100-150 and 200 to meet your filtration requirement.
EASY TO CLEAN—All Marvel Filters are easy to clean. Line type units operate in any position and may be serviced without disturbing pipe connections.
OVER 900 O. E. M's. install Marvel Filters as Standard Equipment.

IMMEDIATE DELIVERY

For further information on a specific type filter—Write—wire or phone

MARVEL ENGINEERING COMPANY
7227 N. Hamlin Ave., Chicago 45, Ill.
Phone: JUniper 8-6023

Please send me information on Marvel Filters as indicated: PMM-4

☐ Hydraulic Oils ☐ Coolants ☐ Lubricants ☐ Fire Resistant Fluids
☐ Water ☐ Sump Type ☐ Line Type ☐ In-Line

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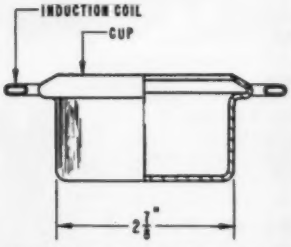
HIGH FREQUENCY *Induction* HEATING UNITS

Lepel induction heating equipment is the most practical and efficient source of heat developed for numerous industrial applications

Typical Induction Heating Applications

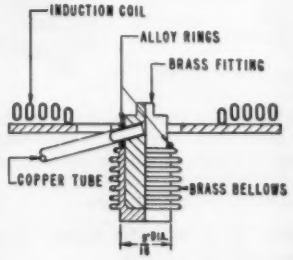
Stainless Steel Cups Selectively Annealed



Flanges of cups made from type 321 stainless steel are selectively annealed by induction heating prior to further forming. Flanges are heated to 2000° F and water quenched. Single-turn coil restricts heating to the flange area.

Our engineers will process your work samples and return the completed job with full data and recommendations without cost or obligation.

Bellows Assembly Brazed



Brass bellows and copper tube are simultaneously silver-alloy brazed to a brass fitting by induction heating. Plate-type induction coil produces proper temperature at each joint.

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1961 MPIF ANNUAL MEETING

The Metal Powder Industries Federation Metallurgy Show will be held on April 25-26, on the two days following the Annual Technical Meeting, April 24.

The combination of meeting and show will be at the Sheraton-Cleveland Hotel in Cleveland, Ohio. Those attending will take advantage of the technical sessions as well as exchanging ideas with powder metallurgy parts producers, and suppliers to the industry.

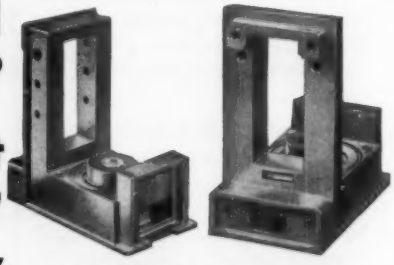
Advanced reservations must be mailed to MPIF headquarters at 60 East 42nd St., New York 17, N.Y. by April 15.

One feature of the annual meeting banquet on April 25 will be the presentation of the first MPIF Powder Metallurgy Pioneer Award, to be given Roland P. Koehring, noted metallurgist of Delco Moraine of General Motors Corp., Dayton, Ohio.

Show Exhibitors

AC Compacting Presses, Inc.
Alan Wood Steel Co.
American Powdered Metals, Inc.
Associated Equipment Co.
Baldwin-Lima-Hamilton Corp.
Charles Hardy, Inc.
Drever Co.
Engineered Plastics, Inc.
Federal-Mogul-Bower Bearings, Inc.
Harper Electric Furnace Co.
Hoeganaes Sponge Iron Corp.
International Powder Metallurgy Co., Inc.
A. Johnson & Co.
Kux Machine Co.
Lindberg Engineering Co.
Mannesmann-Meer, Inc.
Materials In Design Engineering
Mettler Instrument Co.
National Sinter-Seal Co.
New Jersey Zinc Co.
Powdercraft Corp.
PRECISION METAL MOLDING Magazine
Sherritt Gordon Mines, Ltd.
F. J. Stokes Corp.
Vanadium-Alloys Steel Co.

Dimensional Accuracy? YES... but Other 'Specs' are Equally Exacting!

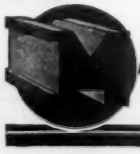


Two views of zinc die-cast body for Air Controlled Timing Valve.

In addition to exacting dimensional tolerances, users of die castings often require other equally precise specifications to be met. For example, in the zinc die-cast body for the Air Controlled Timing Valve pictured, the following requirements were specified to insure successful assembly and functioning: absolute *solidity* and *high density* of the zinc alloy to prevent air leakage — along with a cast-in diaphragm surface absolutely smooth and free from imperfections; bottom of rectangular hole free from burrs; all plane surfaces flat and either parallel or square to one another.

Milwaukee operates under the Certified Zinc Plan of the American Die Casting Institute.

Milwaukee has been meeting exacting requirements like these for more than a half century!



MILWAUKEE DIE CASTING COMPANY

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Established 1909

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and POWDER METALLURGY SHOW

Preliminary Program Schedule

TUESDAY, APRIL 25

9:00 — 11:30

CHAIRMAN
Peter V. Schneider, International Business Machines Corp.

CO-CHAIRMAN
William L. Batten, Vanadium-Alloys Steel Co.

Fabrication of Beryllium Sheet from Powder
B. H. Hessler and J. P. Denny, The Beryllium Corp.
Strengthening Effect of Copper in Infiltrated Sintered Iron Parts
E. H Rennhack, The New Jersey Zinc Co.
High Strength Sintered Parts Made from Titanium Powder
E. P. Weber, Clevite Corp.
Controlled Oxidation Prior to Sintering in Iron and Iron Alloys
H. Harrison and C. G. Johnson, The Presmet Corp.
Effects of Lithium Sterate on Properties of Brass Compacts
R. Powell and F. Zaleski, Frankford Arsenal

2:00 — 4:30

CHAIRMAN
Robert C. Burgess, Burgess-Norton Mfg. Co.

CO-CHAIRMAN
Norbert K. Koebel, Lindberg Engineering Co.

The Handling of Metal Powders for Powder Metallurgical Applications
Arnold Boyce, Delco Moraine Division, GMC
1961 Progress Report: Powder Metallurgy and Metal Powder Industry
Kempton H. Roll, MPIF
Powder Metallurgy Seminar
Sponsored by the Powder Metallurgy Parts Manufacturers Association, a trade division of MPIF

6:30

Cocktail Hour
Restricted to banquet ticket holders

7:30

Special Banquet
In honor of the first winner of the MPIF "Powder Metallurgy Pioneer Award": Roland P. Koehring
Citation by: George A. Roberts, MPIF President
Acceptance by: Mr. Koehring
Winner of the Irving B. Hester Powder Metallurgy Award will be announced at this time

WEDNESDAY, APRIL 26

9:00 — 11:30

CHAIRMAN
Earl Lowe, Greenback Industries, Inc.

CO-CHAIRMAN
Richard S. Gentry, Gentry Carbide Tool & Die Co., Inc.

Today's Tooling
T. Z. Leslie, Micro Carbide Tool & Die Co.
A New Approach to the Study of Powder Compaction
R. W. Heckel, E. I. duPont De Nemours & Co.
Development and Design of Compacting Presses for the Production of Large Powder Metallurgy Parts
B. B. Belden, Baldwin-Lima-Hamilton Corp.
Electrical Discharge Machining as Applied to Powder Metallurgy Tooling
B. M. Bartlett, Monarch Tool & Gauge Co.
Fundamentals of Powder Metallurgy Lecture:
F. V. Lenel, Rensselaer Polytechnic Institute
"Creep in Powder Metallurgy Products"

2:00 — 4:30

CHAIRMAN
Carl G. Johnson, The Presmet Corp.

CO-CHAIRMAN
Benjamin Falk, Arnold Engineering Co.

New Developments in Furnaces for High Temperature Sintering
N. Koebel, Lindberg Engineering Co.
Grain Oriented 50% Ni — 50% Fe Soft Magnetic Alloys from Metal Powders
N. I. Ananthanarayanan, University of Kansas
Influence of Fabrication Techniques on Electrical and Magnetic Properties of Sintered Metals
A. L. Alves, Engineered Plastics, Inc.
A New Look at Hardness-Strength Relationships in Sintered Metals
R. Talmage, Consultant in Powder Metallurgy
Use and Advantages of Metal Powders in Welding Electrode Coatings
D. J. Schaefer, Champion Rivet Co.

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DAYTON 29, OHIO

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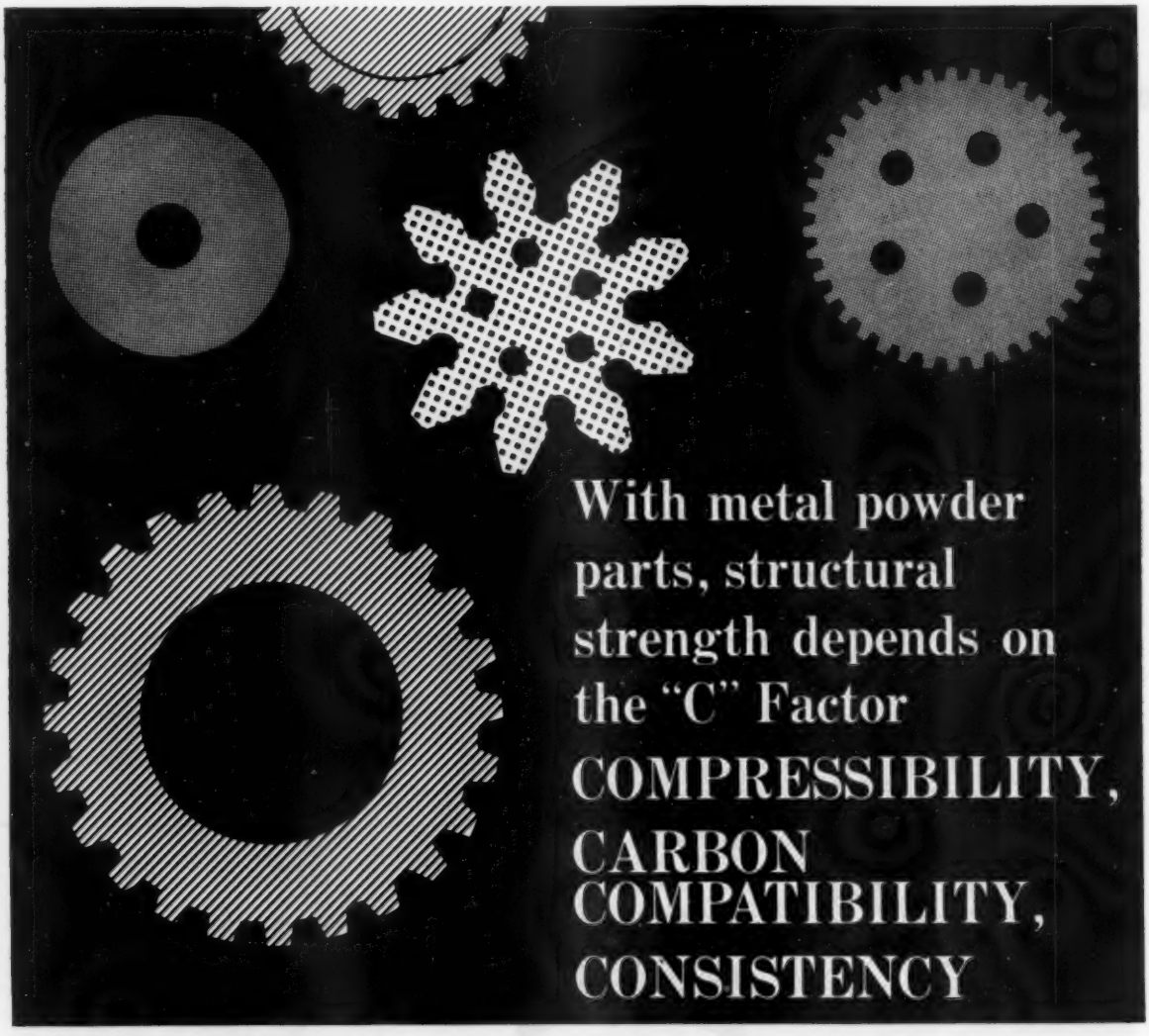
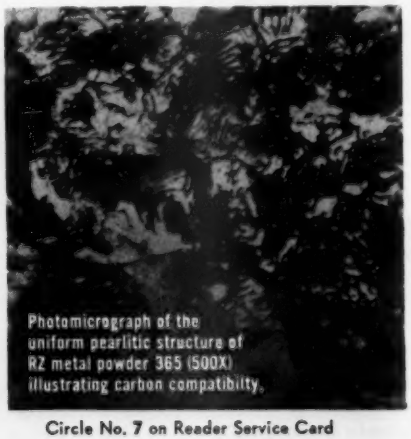


...and only Easton's exclusive RZ iron atomizing process offers the "C" factor! Easton's molding grade powders produced by the RZ process flow better, compact more readily and extrude more easily than powders made by other processes. The flexibility of the RZ process permits variation in the density and surface characteristics of the metallic particles for optimum compressibility... controlled hydrogen loss contributes to high carbon compatibility for improved strength. Close control of chemistry and particle size distribution in the processing and final blending assures the homogeneity and complete consistency of each lot. For quality sintered parts and high density structural applications, select Easton RZ powders in the following grades:

Molding grade powders
RZ 365
RZ 365–HD
RZ 365–M
RZ 365–P
RZ 365–S
RZ–200
RZ–4600 Alloy

"Sintrex" electrolytic grade powders
D–E–F

Custom powders
1. Preblends
2. Customer Specifications


Photomicrograph of the uniform pearlitic structure of RZ metal powder 365 (500X) illustrating carbon compatibility.

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EASTON METAL POWDER COMPANY

EASTON RZ

Division of American Mannex Corporation

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BLackburn 8-6171

10th annual powder metallurgy directory and buyers guide

SECTION 1
PRODUCT LISTING

Advertisers in this issue are listed in bold face type.

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BEARINGS

Allied Sinterings, Inc.

American Powdered Metals, Inc.

American Sinterings

Amplex Div., Chrysler Corp.

Arrow Sintered Products Co.

Asco Sintering Corp.

Bassick Co.

Bound Brook Bearing Corp. of America

Brockway Pressed Metals, Inc.

Bunting Brass & Bronze Co.

Carbon City Products Co., Inc.

Ceromet, Inc.

Chicago Powdered Metal Products Co.

Cleveland Graphite Bronze, Div. of Clevite Corp.

Compacted Metals Corp.

Delco Moraine Div., General Motors Corp.

Deva-Metal Div., S. K. C. Research Associates

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Eaton Mfg. Co., Powdered Metals Div.

Elco Sintered Alloys Co.

Engineered Plastics, Inc., American Sinterings Div.

Federal-Mogul Div., Federal-Mogul-Bower Bearings, Inc.

Ferro Powdered Metals, Inc.

General Sintering Corp.

Gilman Engineering & Manufacturing Co.

Haller, Inc.

Indar Corp.

International Powder Metallurgy Co.

International Powder Metallurgy, Inc. Rocky Mountain Metals Div., Inc.

Johnson Bronze Co.

Keystone Carbon Co.

Kirkwood Carbon Co.

Kwikset Powdered Metal Products, Kwikset Div., American Hardware Corp.

Lux Clock Mfg. Co., Inc.

A. B. McMahan Co.

Merriman Brothers, Inc.

Metal Ceramics Powdered Metal Products

Metal Powder Products, Inc.

Mueller Brass Co.

National Molded Products, Inc.

Norwalk Powdered Metals, Inc.

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Allegheny Ludlum Steel Corp., Carmet Div.

Carbidie, Inc.

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Indar Corp.

Kennametal, Inc.

Schwarzkopf Development Corp.

Tungsten Alloy Mfg. Co., Inc.

Valenite Metals, Div. The Valeron Corp.

Vascoloy-Ramet Corp.

Wesson Co.

Wesson Metal Corp.

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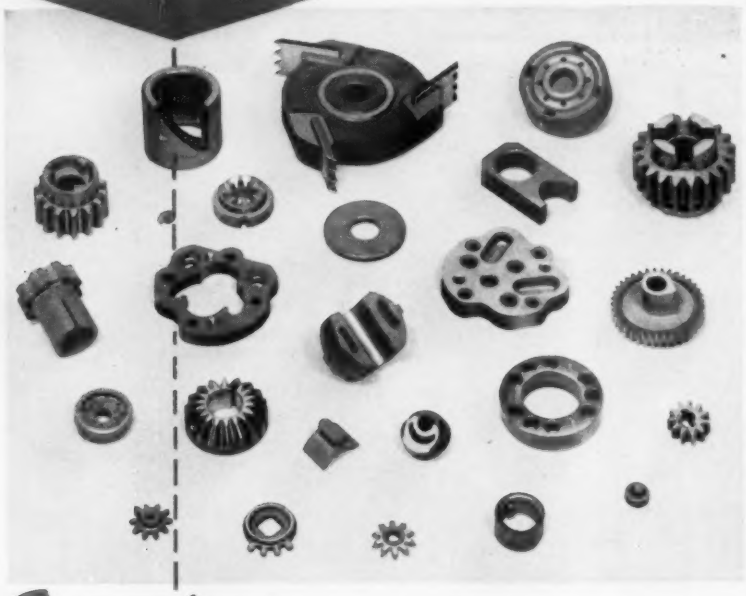
POWDERED METAL PARTS



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American Sinterings

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Metal Powder Products, Inc.

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PBM
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Powdercraft Corp.

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Raybestos-Manhattan, Inc., Wabash Div.

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HIGH DENSITY
MECHANICAL & ELECTRICAL PARTS

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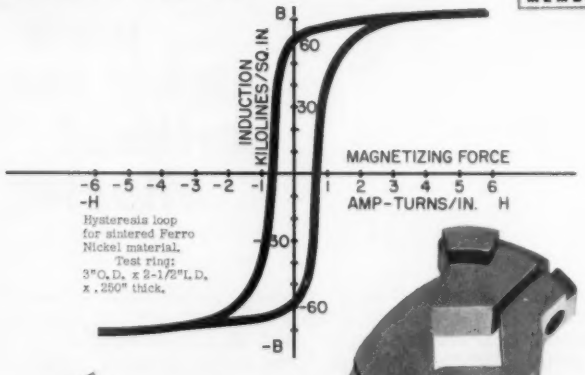
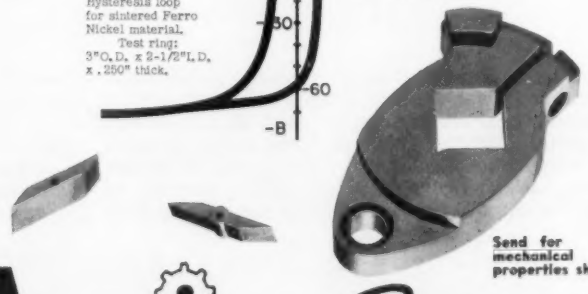


Hysteresis loop for sintered Ferro Nickel material. Test ring: 3"O.D. x 2-1/2"I.D. x .250" thick.



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Carbon City Products Co., Inc.

Ceromet, Inc.

Chicago Powdered Metal Products Co.

Compacted Metals Corp.

Delco Moraine Div., General Motors Corp.

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MADE TO YOUR SPECIFICATIONS
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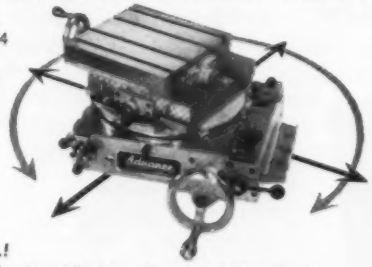
In use since 1954 for Rotary and Angular Milling of Die and Mold Cavities



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Romanoff Machine & Tool Co.
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Sintered Metals, Inc.
Sterling Engineering Corp.
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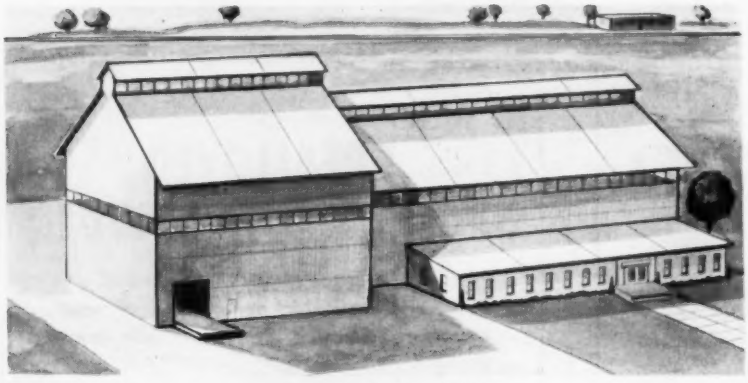

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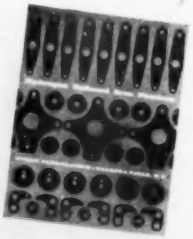

PYRON COMPANY
AMCO Division, American Metal Climax, Inc.
NIAGARA FALLS, NEW YORK
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Henry Bower Chemical Mfg. Co.
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The Electric Furnace Co.
Ferguson Equipment Corp.
General Electric Co., Apparatus Sales Div.
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Holcroft & Co.
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C. M. Kemp Mfg. Co.
Lindberg Engineering Co.
Sunbeam Equipment Corp.
Surface Combustion Div. Midland-Ross Corp.

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Bethlehem Steel Corp.
Braeburn Alloy Steel Corp.
Carpenter Steel Co.
Columbia Tool Steel Co.
Crucible Steel Co. of America
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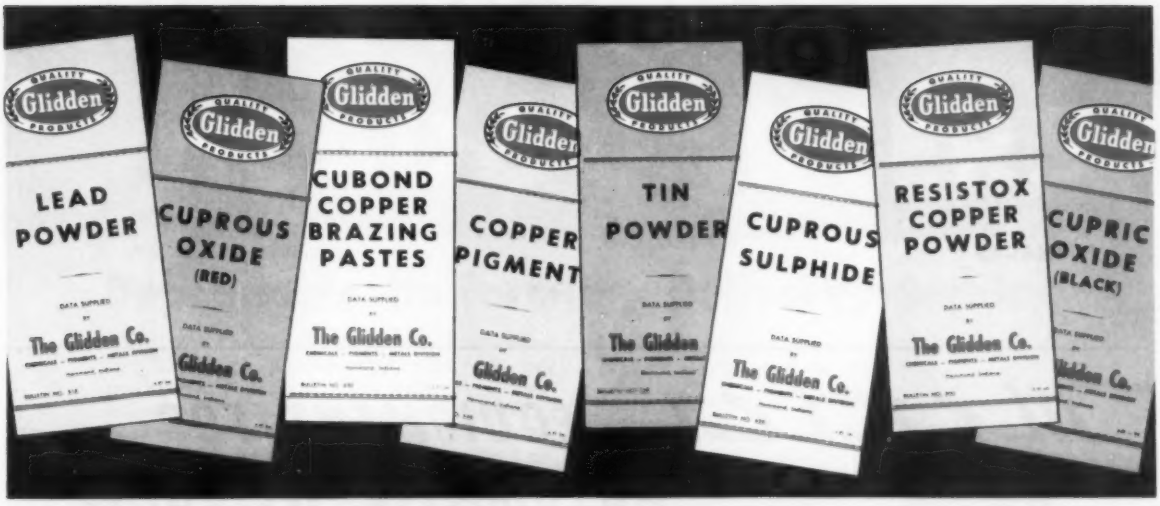

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F. J. Stokes Corp.

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Joseph Dixon Crucible Co.

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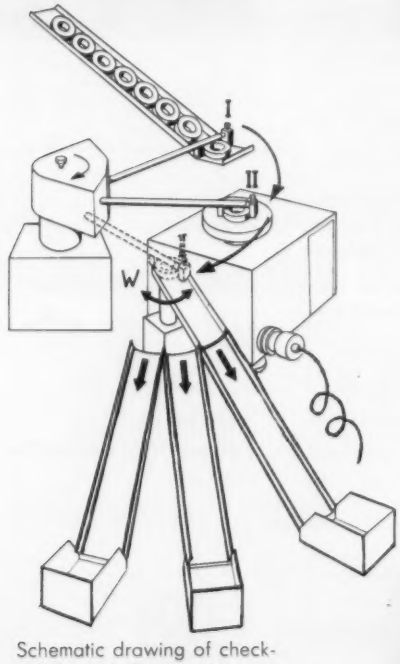

Schematic drawing of check-weighing and sorting operation.

Weighing accurate charges of metal powder - directly into die cavity - at rate of 10 to 15 per minute.

Check-weighing and sorting of molded parts at rate of up to 60 per minute.

METTLER invites you to see this modern equipment at Booth No. 3, 1961 Powder Metallurgy Show, Cleveland, Ohio, April 24 to 26.

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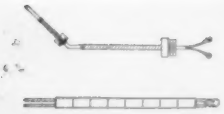

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Drever Conveyor Belt Sintering Furnaces, custom engineered to suit the individual producer, are handling an ever widening range of sintered products in plants across the country.

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lead

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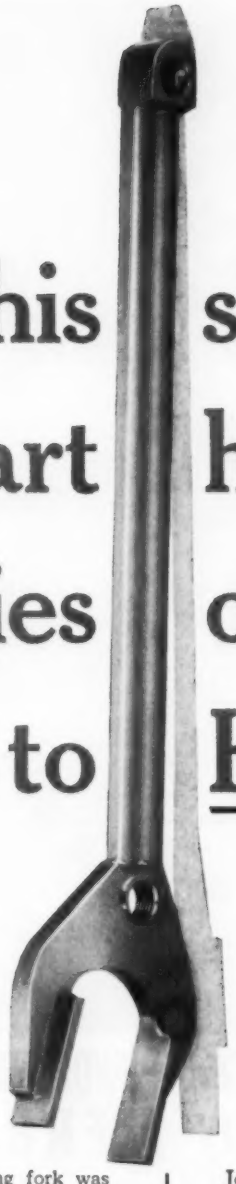
This sintered iron part has the properties of a forging, thanks to High Density



This sewing machine feed connecting fork was orginally made as a forging. Now produced from HVA Star Grade Electrolytic Iron Powder plus 2% copper, pressed and sintered to a density of 7.1 ±0.1 grams/cc, it shows these mechanical properties:

Tensile strength	**57,000 psi**
Yield strength	**46,000 psi**
Elongation	**15%**
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Johnson HVA and MSS Electrolytic Iron powders have such high purity that cold pressing produces better than 90% relative density and an extremely compact grain structure. The physical and mechanical properties of the sintered part approach those of a forging. Moreover, the compact grain structure makes for a high degree of metallurgical and dimensional uniformity from part to part, as well as good machining and threading properties.

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National Lead Co.

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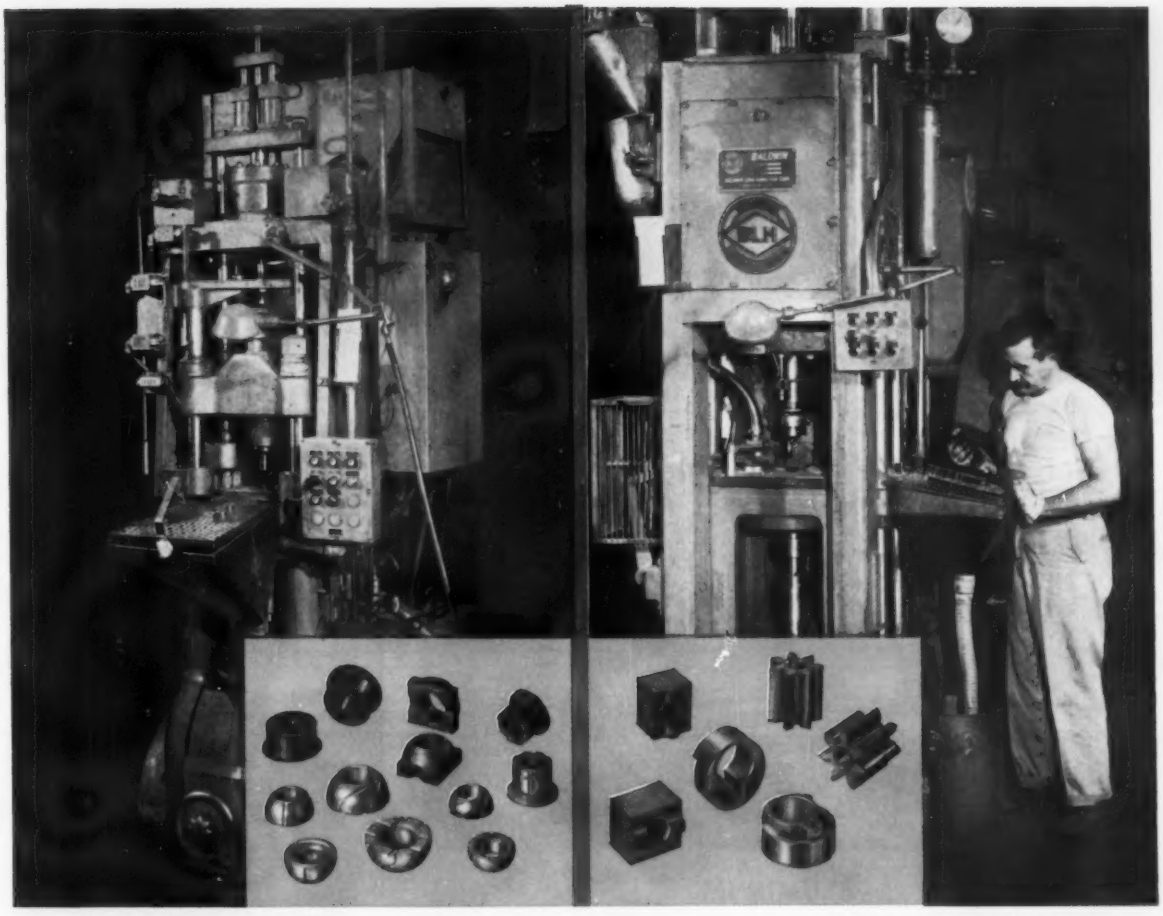

75-ton Baldwin compacting press shown with typical parts it forms at high speed.

50-ton Baldwin compacting press and some of the many parts it forms at low cost.

Speed and versatility make Baldwin the smart buy in compacting presses

Before you select your next compacting press, compare the extra versatility you get with Baldwin. No other press is so adaptable to your changing requirements. Extra multiple motions offered as accessories can easily be added at any time.

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steel

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National Lead Co.

zinc

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National Lead Co.

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NON-METALLIC

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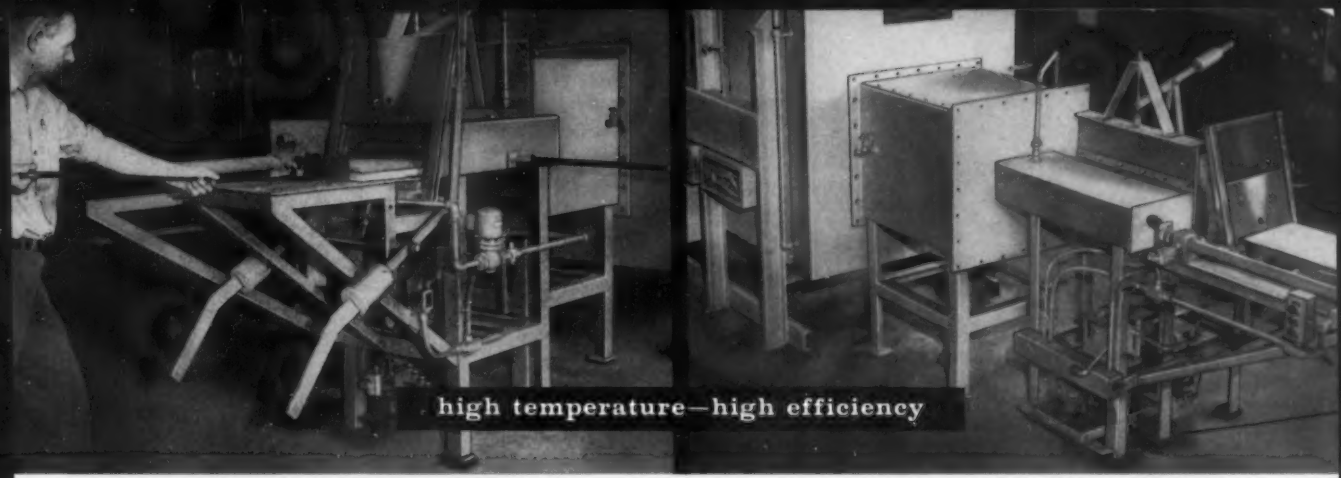

This new Lindberg Molybdenum Element Pusher Type Atmosphere Furnace has a maximum temperature of 3000°F. with 60KW input. It embodies high temperature refractories suitable for low dew point without muffle and is ideal for sintering stainless steel compacts in hydrogen or dissociated ammonia. Furnace provides side loading and discharge ports with purging chambers. Installation at right also shows conveniently located ammonia dissociator and control panels.

If your production processes require sintering you can depend on getting exactly the right equipment for your needs from Lindberg's comprehensive line of dependable, efficient, production-proven furnaces

This Lindberg Mesh Belt Continuous Type Furnace has a temperature range of 1300°F. to 2100°F. and production capacity up to 500 lbs. per hour. It is a very popular type furnace for sintering small metal powder parts. Similar furnaces are also being used for brazing and bright annealing.

Lindberg Roller Hearth Continuous Type Furnace handles loads up to 2200 lbs. per hour in temperature range 1300°F. to 2100°F., for bright annealing, silver brazing and sintering metal powder.

Lindberg Hand Pusher Batch Type Furnace has a temperature range of 1300°F. to 2500°F. Also sintering capacities from 25 to 300 lbs. per hour available.

For full information on the furnaces illustrated and Lindberg's complete line of sintering and brazing furnaces, just get in touch with your local Lindberg Field Representative (see classified phone book) or write direct. Please remember, too, that Lindberg offers a variety of Atmosphere Generators to provide, efficiently and economically, the proper atmospheres recommended for use with our sintering furnaces. Heat Treating Furnace Division, Lindberg Engineering Company, 2463 West Hubbard Street, Chicago 12, Illinois.

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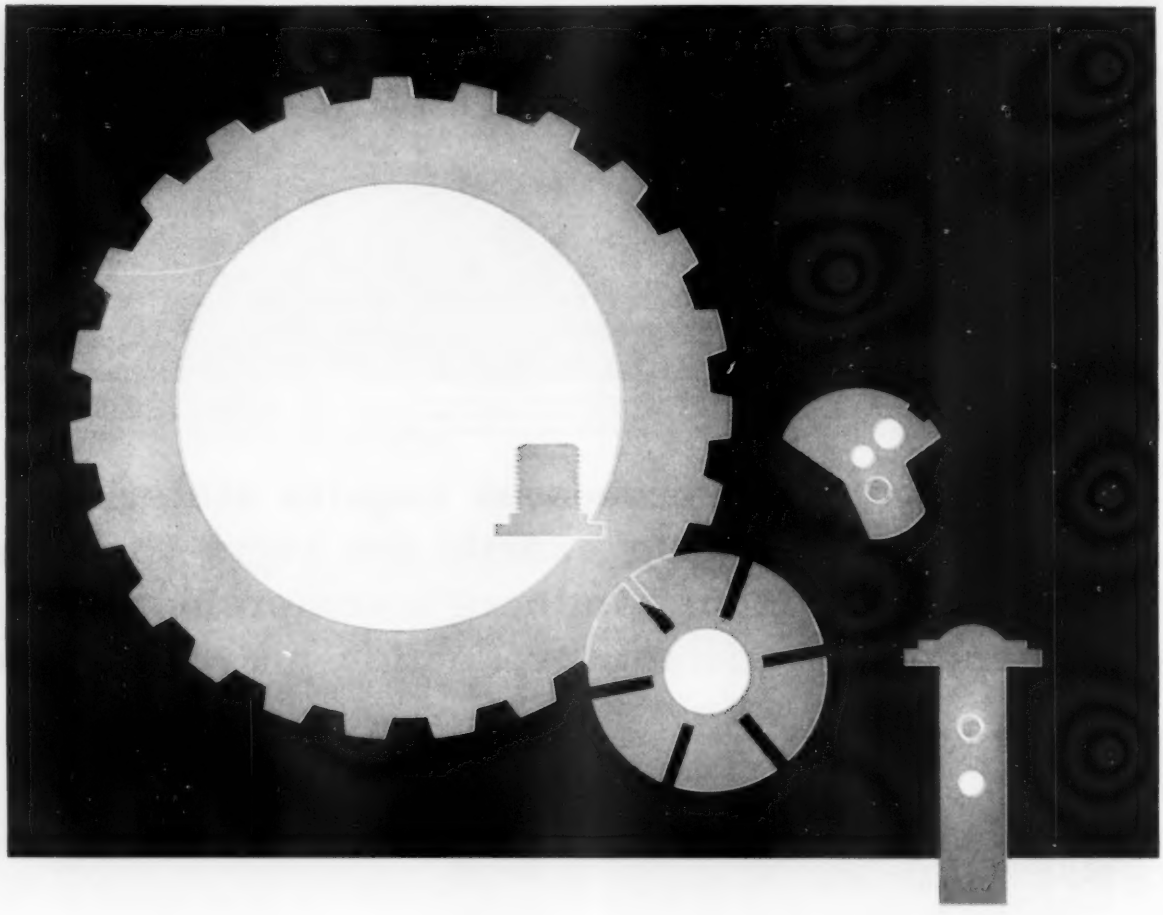

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Metals Disintegrating Company will supply any manufacturer, anywhere in the world, a specific grade of powder in aluminum, tin, copper and other metals and alloys in a wide range of particle sizes. Our complete laboratory and testing facilities are at your disposal to help you select the grade and material for your product.

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Circle No. **50** on Reader Service Card

10th annual powder metallurgy directory and buyers guide

SECTION 2
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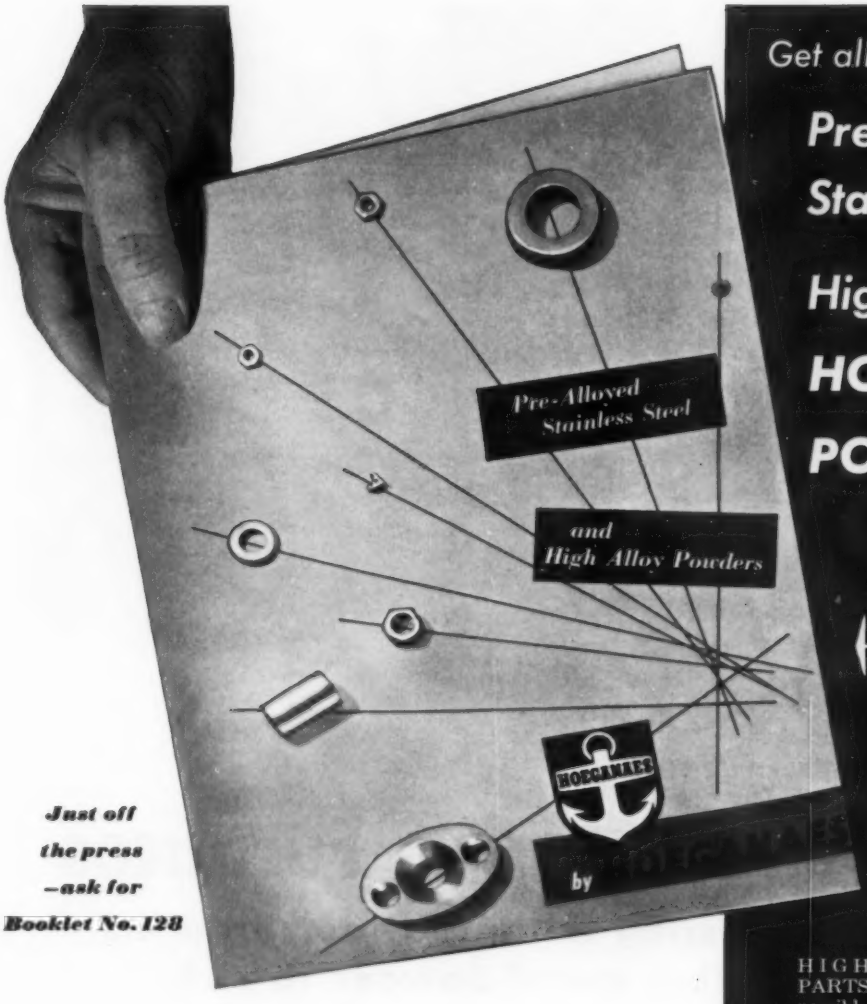

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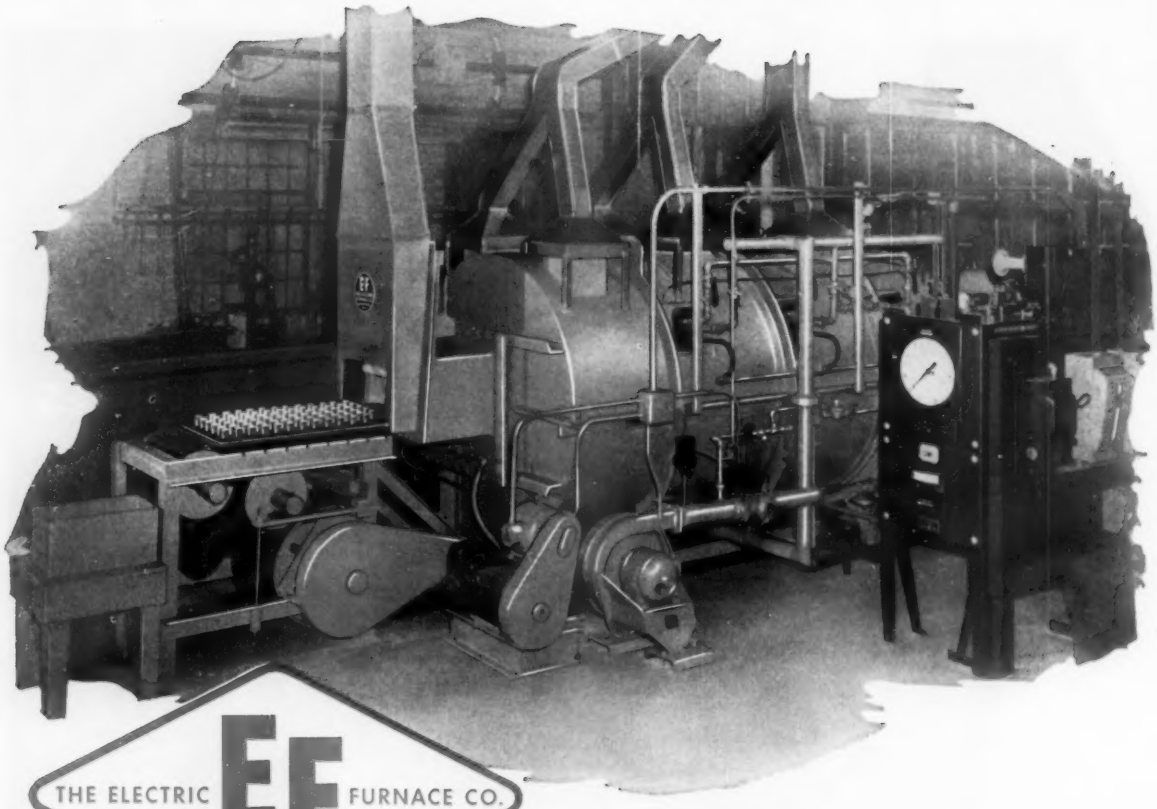

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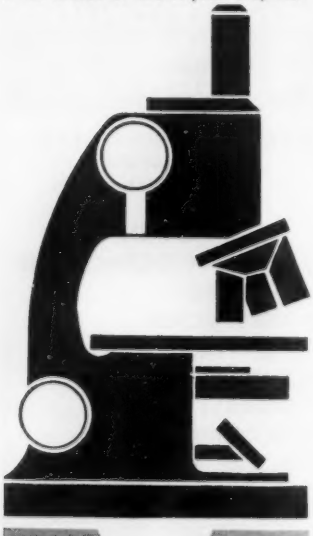

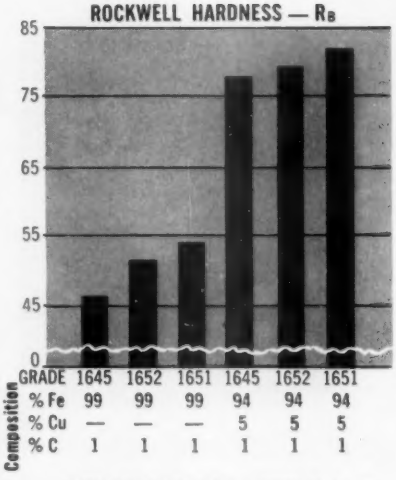

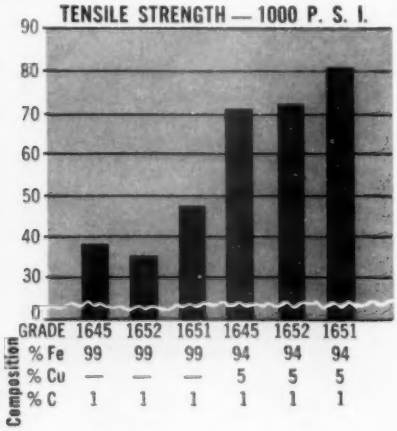

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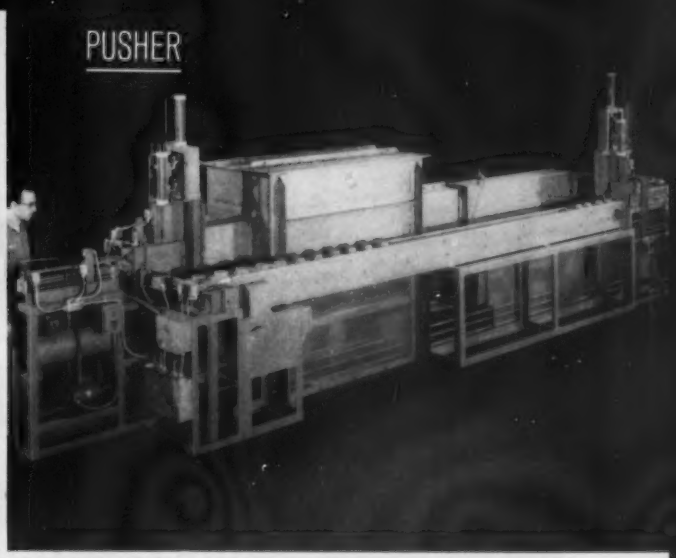

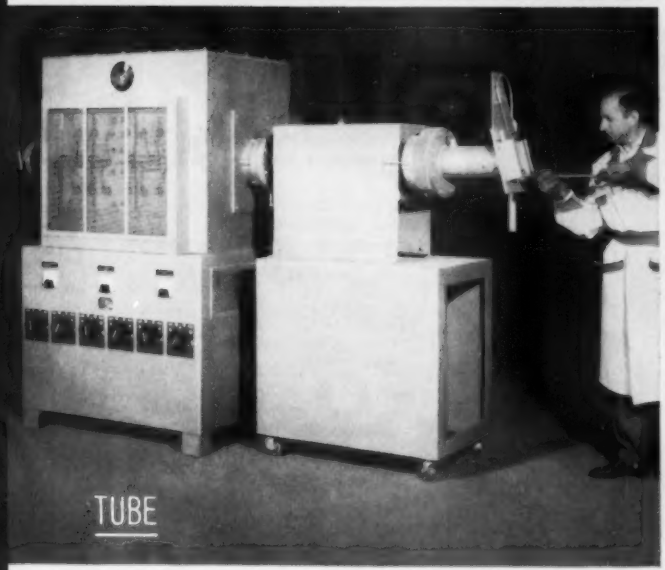

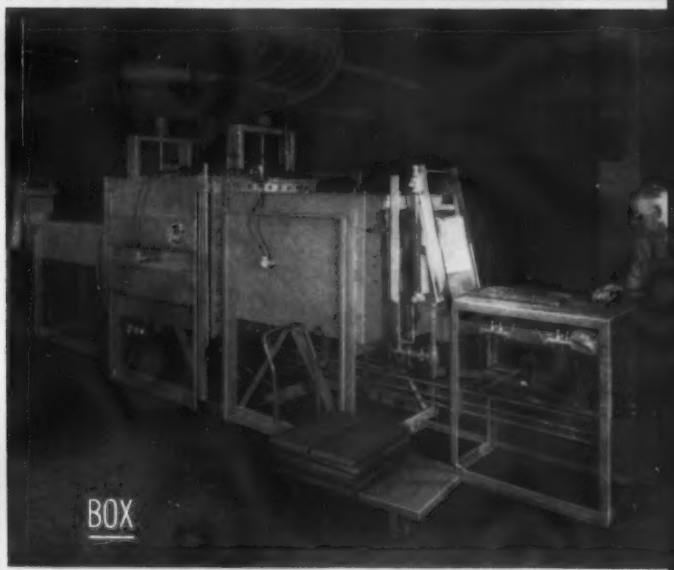

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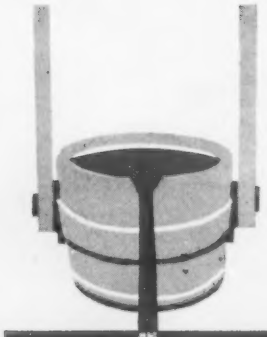

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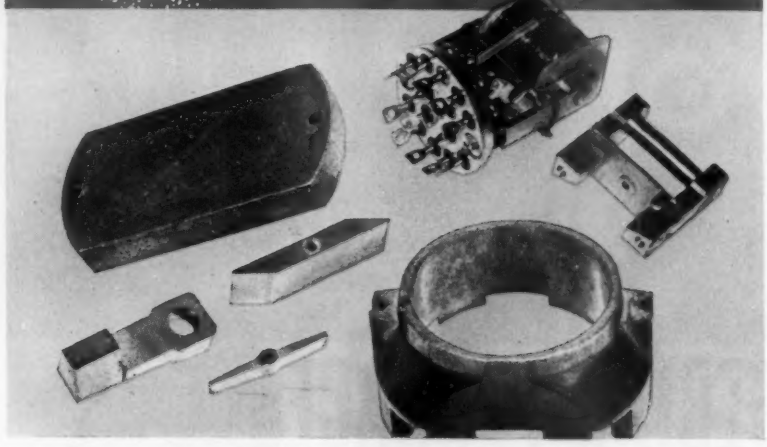

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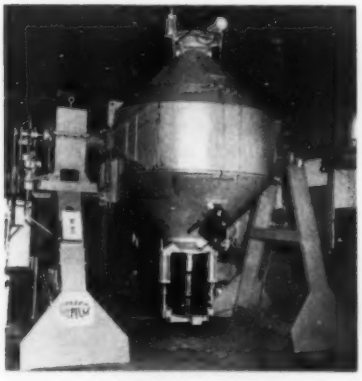

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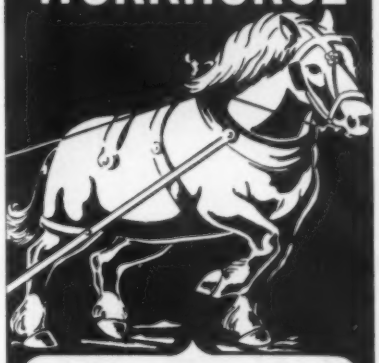

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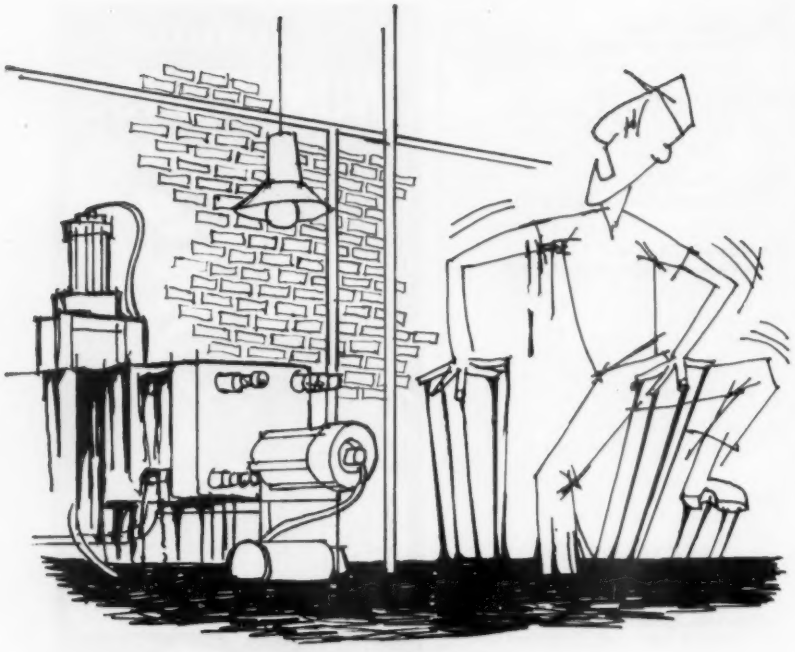

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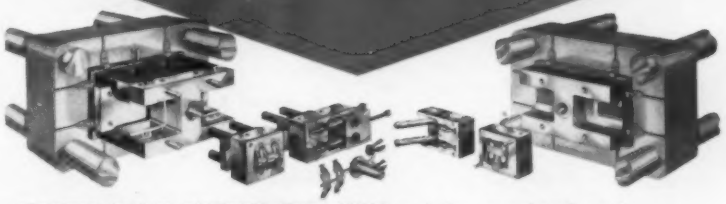

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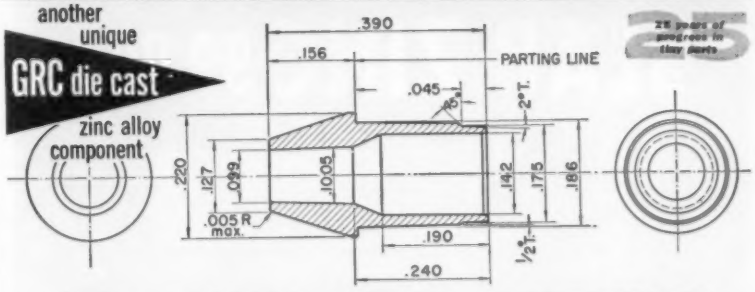

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